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THE FIFTH CONGRESS OF THE TRADE UNION OF METALLURGISTS

V. A. Podzerko

Chairman of the Central Committee of the Trade Union of Workers in the Metallurgical Industry

Translated from Metallurg, No. 5, pp. 1-3, May, 1960

On May 10, 1960, the Fifth Congress of the Trade Union of Workers in the Metallurgical Industry opens. Here will be summed up the results of the work of the Central Committee of the Trade Union on the fulfillment of the decisions of the Twentieth and Twenty-first Congresses of the Party, of the December (1957) and June (1959) Plenums of the Central Committee of the Communist Party of the Soviet Union, of the Twelfth Congress of Trade Unions, and the Fourth Congress of the Trade Union of Metallurgists.

The Congress will determine the priority tasks of metallurgists for fulfilling the decisions of the Twenty-first Congress of the Communist Party of the Soviet Union in the struggle for fulfilling the Seven-year Plan and the plan of the second year of the Seven-year Plan ahead of schedule.

The Presidium of the Trade Union Central Committee prior to the Congress organized reports on the work of the Trade Union Central Committee at trade union meetings in cities having a large number of metallurgical enterprises and at certain large enterprises.

The past period is noteworthy for the reorganization of the work of the trade union in the light of the decisions of the December (1957) Plenum of the Central Committee of the Communist Party of the Soviet Union "on the work of the trade union in the USSR" which defined the tasks of the trade unions under new historical conditions.

The course taken by the Party for the ubiquitous development of initiative, the enlargement of the rights of the local party, council, trade union and economic organizations, the transfer of authority of the operational management to the republics, to the krays, and to the oblasts radically changed the tasks, the rights and the responsibilities of the trade union central committees and enabled them to concentrate their attention mainly on solving the problems of branch industries.

The Twenty-first Congress of the Communist Party of the Soviet Union has assigned great and responsible tasks to the metallurgists. Metallurgists by 1965 will have to smelt 65-70 million tons of pig-iron, 86-91 million tons of steel, and produce 65-70 million tons of rolled products.

Inspired by the grandiose perspectives the collectives of the leading metallurgical enterprises—the "Zaporozhstal'" Plant, the Ust'-Kamenogorskii Lead and Zinc Combine, and the Krivoi Rog Ore-Concentration Combine—appealed to all metallurgists in the USSR to develop socialist competition for the early fulfillment of the 1959 plan, which was the first year of the Seven-year Plan.

The Presidium of the Trade Union Central Committee approved and supported this valuable initiative. The collectives of all metallurgical enterprises participated in socialist competition for the early accomplishment of the plan for the first year of the Seven-year Plan.

The name of one of the initiators of the competition for increasing the productivity of metallurgical units, the distinguished steel worker of the country, Anatol Dmitrievich Morogov, is now known far beyond Nizhne Tagil. Participating in socialist competition to fulfill the Seven-year Plan ahead of schedule, Comrade Morogov in 1959 attained the highest production indices among the steel workers of the Combine. Last year the brigade which he headed smelted 1754 tons of steel in excess of the plan, removed 10.83 tons of steel from a square meter of hearth while the average removal of steel for the country was 7.86. The steel workers at Zaporozh do not lag behind the distinguished Ural innovator. The operational experience of Comrade Morogov's brigade and of the Zaporozh steel workers was frequently noted in the decrees of the Presidium of the Central Committee of the Trade Union and in the press.

N. V. Pereverzev, steel worker at the "Azovstal'" Plant, following the initiative of N. Mamay and A. Kol'chik, proposed to organize a competition for producing goods of excellent quality. The initiative of Comrade Pereverzev, approved by the Presidiums of the All-Union Central Council of Trade Unions and the Trade Union Central Committee was widely proclaimed in metallurgy.

The patriotic movement for the right to be called a shock worker and a brigade of communist labor reached an enormous scale in the enterprises of the metallurgical industry. Now we not only have brigades, but entire shops of communist labor. According to the far-from-com-

plete data more than 200,000 workers are participating in this notable movement at metallurgical enterprises.

The Presidium of the Trade Union Central Committees generalized the results of the group conferences held by the participants in the movement for the right to be called a shock worker and a collective of communist labor, and made a number of recommendations for improving the work of the trade union committees in guiding this important movement.

The Presidium of the Trade Union Central Committee established that the positive operational experience of trade union organizations for mobilizing metallurgists for an early fulfillment of the Seven-year Plan become the property of all trade union organizations. For this purpose the operational experience of the factory committee of the Dzerzhinskii Plant on the organization of intraplant competition was studied and disseminated, together with that of the factory committee of the Nizhne Tagil Metallurgical Combine on the mobilization of workers for achieving the highest indices in the use of metallurgical units, of the factory committee of the Magnitogorsk Metallurgical Combine on uncovering production reserves and on increasing the productivity of labor, as well as the operational experience of the constantly active production conferences at metallurgical enterprises in the Dnepropetrovsk, Chelyabinsk, Kemerovo, Zaporozh and other regions, and also the experience of the Chelyabinsk regional trade union committee on the organization of work and the guidance of trade union organizations under new conditions.

Commissions for promoting technological progress were organized and put into effect at many enterprises. At the Magnitogorsk, Kuznets, and Nizhne Tagil Metallurgical Combines and the "Zaporozhstal'", "Azovstal'" Plants and many others,the problems of technological progress were a subject of discussion at the constantly active production conferences.

In order to attract more workers, engineers, and technicians to the task of solving the problems of complex mechanization and automation of production and in order to improve the guidance of the movement of innovators and inventors on the part of trade union committees, the Central Committee and the All-Union Society of Inventors and Innovators proclaimed a competition for the best staging of the work of innovators and inventors at metallurgical enterprises from January 1 to July 1, 1960.

The great work of the trade union organizations on the mobilization of metallurgists for the fulfillment of the plan ahead of schedule yielded remarkable results. The collectives of the metallurgical enterprises fulfilled the 1959 State Plan early, and the country received 307,000 tons of pig iron, 870,000 tons of steel,940,000 tons of rolled products, and 1,700,000 tons of iron ore in excess of the plan.

The achievements attained in the past year and the additional reserves for the growth of productivity that were uncovered during the competition made it possible to provide in the 1960 plan higher tasks than were calculated for in the Seven-year Plan.

In the current year metallurgists must smelt 47.07 million tons of pig iron, 64.92 million tons of steel, produce 50.25 million tons of rolled products, 5.85 million tons of steel pipes, and considerably increase the output of nonferrous and rare metals.

The struggle to fulfill ahead of schedule the plan for the second year of the Seven-year Plan developed at the enterprises from the very first days of the current year under the leadership of the trade union organizations.

However, there are still a great many substantial shortcomings in the work of the trade union committees for the mobilization of the collectives for the early accomplishment of the Seven-year Plan, and the main task of the trade unions is to overcome these.

In the organization and management of socialist competition,trade union committees of certain enterprises still permit formalism, devote more attention to red-tape methods than to business-like and concrete aid to the workers and individual collectives in fulfilling their obligations.

In recent times,the work of disseminating the most advanced labor methods of the metallurgical innovators has noticeably weakened and the work of the interplant school for teaching the latest methods is still unsatisfactory.

The Trade Union Central Committee together with the State Committee on Problems of Labor and Wages have worked out, in connection with the change to a shorter working day and regulation of wages, new wage rates and scales, regulation of premiums, and wage-scale reference books for skilled workers. Trials have been made of the new rate and wage systems at many enterprises.

Regional meetings were held in the South, in the Urals, Kazakhstan, and in Siberia in order to render practical assistance to the economic managers and to the trade union committees in accomplishing the change to a shorter working day and to the new conditions for payment of labor. The political and economic significance of the change to a shorter working day and to the new conditions for payment of labor were explained at the enterprises, and organizational and technical measures were developed for improving the organization of labor and production, for reducing the cost of production and improving the quality of the products, and for increasing the productivity of labor.

The realization of these measures made it possible, as a whole, in ferrous metallurgy to reduce by 50% the additional demand for workers needed for the change to a shorter working day.

The change to new conditions of labor payment increased the specific weight of the technically based output norms from 67 to 82% in the main shops and from 66.6 to 75% in the auxiliary shops; the specific weight of the wage rates in the total earnings of the workers increased from 60.6 to 73.5%, and the average monthly wage increased by 13.5%. The wages of workers entering the profession of basic metallurgical production increased by 25-30%.

The wages of the low-paid category of workers were considerably increased. The number of workers with wages to 600 rubles was decreased by a factor of 2.5. The gap in the wages between management personnel and workers was reduced.

During the two years of working on a shorter working day and under the new conditions for labor payment the monthly productivity of labor in ferrous metallurgy increased by 8% and when calculated per hour of labor, by 20%. The plan for the productivity of labor for 1959 was fulfilled in ferrous metallurgy by 101.9%, which in relation to 1958 is 105.3%.

The Trade Union Central Committee took decisive measures to eliminate shortcomings arising at places when effecting the changeover to a shorter working day and to the new conditions for payment of wages, in particular to correct the deviations from the wage-scale reference books for skilled workers, to increase the specific weight of the technically based norms in the auxiliary shops and for the auxiliary operations, to correct the relationship between the growth of labor productivity and the growth of labor wages, and to decrease the number of workers not fulfilling the output norm.

During the current period the Trade Union Central Committee solved many important branch problems directed toward improving the protection of workers, techniques of safety, and industrial sanitation.

The Trade Union Central Committee in conjunction with scientific and technical societies held a scientific-technical conference in August 1958 at Stalino (Donbass) on the assembly of metallurgical furnaces and protection of workers; in March 1959 at Krivoi Rog a conference was held on improving labor conditions and safety techniques in sinter production; in June 1959 at Dnepropetrovsk a scientific-technical conference was held on protection from heat and radiation.

The Trade Union Central Committee has developed and sent to the appropriate Union and Union republic departments concrete suggestions for eliminating the faults in safety techniques and in industrial sanitation for the equipment being produced in lots for the metallurgical industry. The Councils of Ministers of the Russian Federation, Ukraine, Azerbaidzhan, Armenia, and certain other Union Republics have already taken specific steps to accomplish the suggestions of the Trade Union Central Committee, and to eliminate these shortcomings.

The safety rules for open-hearth, blast-furnace, rolling-mill, fire clay, netting, wire and nail, and ferroalloy productions have been revised.

Typical aspects developed and approved by the Presidium of the Trade Union Central Committee are: "A study room for safety techniques," "Dust ventilation service at mines and concentration plants of metallurgical enterprises," "The work, rights, and responsibilities in safety techniques and industrial sanitation for administrative and technical personnel and offices of safety techniques at enterprises of the metallurgical industry," etc.

The further improvement in the protection of workers, safety techniques, and industrial sanitation is a great and serious task for the Trade Union. The Trade Union Central Committee must see that the trade union committees of the enterprises show greater exactingness and implacability toward the shortcomings in the field of labor protection, that they attract more trade union members to an awareness of their work, and that they use fully their rights for accomplishing state supervision over observation of the labor laws and social control over the condition of labor protection.

The Trade Union Central Committee during the current period participated more actively in the work of the International Union of Trade Unions of Workers in the Mining Industry.

The Trade Union Central Committee has established relations with trade unions of metallurgists in more than 40 foreign countries, including all countries of the people's democracy. Metallurgists and miners of Hungary, Czechoslovakia, Rumania, Bulgaria, Poland, Belgium, France, Bolivia, Austria, and Chile were guests of the Trade Union Central Committee within two years. Trade Union delegations of metallurgists of our country went to Austria, Poland, China, Czechoslovakia, the German Democratic Republic, Belgium, Hungary, and Yugoslavia.

The mutual exchange of delegations contributed to the further strengthening of the bonds between Soviet metallurgists and metallurgists of foreign countries.

In recent times the work of disseminating abroad the achievements of Soviet workers has been greatly improved and correspondence has been established between many trade union committees of metallurgical enterprises in the USSR and trade unions of similar enterprises abroad.

Endeavoring to make their contribution to the struggle for the most rapid fulfillment of the measures to be taken for a further rise in agriculture, as noted by the December (1959) Plenum of the Central Committee of the Communist Party of the Soviet Union, the collectives of metallurgists at Magnitogorsk, Dnepropetrovsk, Zaporozh, and Gor'kii developed a competition for above-the-plan metal for the needs of agriculture; the collective of the Kuznets Metallurgical Combine came forward as the initiator of socialist competition for an economic expenditure of pig iron, ferroalloys, metal charges, and steel for each ton of finished rolled products.

The Presidium of the Trade Union Central Committee approved the valuable initiative of the foremost collectives and made it known to all enterprises in the Soviet Union.

Participating in the pre-May competition, the metallurgists honorably fulfilled the great pledges they had taken and the national holiday and opening of the Fifth Congress of their Trade Union was greeted by tens of thousands of tons of metal in excess of the plan.

* * *

THE ROLE OF COMPETITION IN THE DISSEMINATION OF THE MOST ADVANCED PRACTICE OF ORGANIZING PRODUCTION AND LABOR

R. L. Zaitsev

Moscow Economic-Statistical Institute (From the experience of the competition between the Moscow "Serp and Molot" Plant and the Stalingrad "Krasnyi Oktyabr'" Plant)

Translated from Metallurg, No. 5, pp. 3-5, May, 1960

The collectives of metallurgical enterprises are presently experiencing a tense creative life. The historical decisions of the Twenty-first Congress of the Communist Party of the Soviet Union and of the June and December (1959) Plenums of the Central Committee of the Communist Party of the Soviet Union called for a new, powerful increase in national competition for the early fulfillment of the plan for the second year of the Seven-year Plan. To be in the vanguard of this competition is not only the task but also the distinguished duty of Soviet metallurgists who provide industry with metal. Under these conditions the dissemination of the most advanced practice acquires an especially important meaning. Socialist competition, which ensures mass distribution of advanced labor methods, is the most important method of mobilizing workers to the search for the most complete use of all productive reserves.

Similarity of production and products makes it possible to transfer quickly and concretely all that is the best, newest and most advanced at one enterprise to another. The twenty-two year experience of the traditional competition between the metallurgists of the Moscow "Serp and Molot" Plant and the Stalingrad "Krasnyi Oktyabr'" Plant graphically demonstrates the effectiveness of competition between related enterprises. During the course of the competition both plants constantly improved the work indices and attained no small production achievements. Both enterprises overfulfilled the 1959 annual plans, producing thousands of tons of steel and rolled products in excess of the plan, and succeeded in reducing the cost of production and increasing the productivity of labor.

All this was achieved not because of the installation of new productive facilities, but by the best utilization of the equipment available, by the best organization of production and labor which developed during the competition between the workers and the engineer-technicians of both plants. Thus at the "Krasnyi Oktyabr'" Plant the heating processes of all open hearth furnaces and the majority (more than 70%) of the reheating furnaces were made automatic according to the experience of the "Serp and Molot" Plant and with the aid of its representatives. One hundred and seven metallurgical and power units were automated at the plant since the Twenty-first Congress of the Communist Party of the Soviet Union. About 3000 instruments and about 300 automatic units were installed. Numerous measures were taken to mechanize labor-consuming processes: the coolers of the 450-mm mill and the dressing of the walls and bottoms of open-hearth furnaces were mechanized; the heated blanks from the furnaces of the merchant-mill shop are now delivered mechanically, turning of the metal on the 750-mm mill was mechanized which permitted the release of 20 workers, and the delivery of hot ingots from the open-hearth mills to the soaking pits of the blooming mill was mechanized, as well as other sectors of production. As a result of all this, manual operations were considerably reduced at the "Krasnyi Oktyabr'" Plant. From the practice of the Moscow workers the Stalingrad metallurgists introduced into production roll passes on the No. 1 450-mm mill, on the No. 2 450-mm mill and on the 325-mm mill, eliminated the rod on the drawbenches of the sizing shop, introduced alkali and sulfuric acid etching of cold-rolled stainless

steel, an exothermal mixture for warming the hot top of ingots, conveyor-type furnaces for the sheet-rolling shops, and a number of other measures.

These measures alone enabled the "Krasnyi Oktyabr'" Plant to increase the output of the rolling mills by 6-7%, to decrease rejections by 20%, and to increase the yield of useful metal by 2%.

The "Serp and Molot" Plant, in its turn, by studying the practice of the "Krasnyi Oktyabr'" Plant and with the direct participation of its representatives, improved the technology of annealing roller-bearing steel. This cut heat treatment time by 20%, improved the structure of the steel, and decreased rejects due to decarburization by a factor of 3-4. In addition to this the Muscovites imitated the Stalingrad workers' practice of using natural gas for heating the open-hearth and reheating furnaces. Owing to the mutual exchange of the work experience of the laboratories at both plants the technology of producing hollow drill steel was considerably improved and a good uniformity in the structure of heat-resistant alloys was attained.

Thus the traditional competition of the Moscow and Stalingrad metallurgists contributed to an increase in the output of goods by both plants. Participating in the competition for a match worthy of the Twenty-second Congress of the Communist Party of the Soviet Union, both plants have taken upon themselves the following increased obligations for 1960.

	"Serp and Molot"	"Krasnyi Oktyabr'"
To deliver over the plan:		
steel, tons	5000	10,000
rolled products, tons	3000	10,000
To increase labor productivity as against the plan, %	1	1
To decrease the cost of production as against the plan, millions of rubles	1	4
To reduce the losses from rejects as against 1959, %	5	15
To save electrical power, millions of kw-hr.	2,8	5,5
To introduce into production innovators' suggestions with an annual savings, millions of rubles	2	10
To increase the qualifications of workers, engineer-technicians, and office workers	1200 men	3000 men
To teach the most advanced labor methods	400 men	25 schools

In the traditional competition between the collectives of the plants the Stalingrad metallurgists won the championship in the first, third and fourth quarters of 1959. One of the reasons for this was the more wide-scale intraplant competition in its modern, most progressive forms. In particular, the Stalingrad metallurgists picked up the initiative of V. I. Gaganova with the same energy as in competition for the right to be called collectives and shock workers of communist labor. Now the plant has ten "Gaganovites."

In August 1959 the distinguished steel worker, Hero of Socialist Labor, A. F. Serkov was transferred to a furnace that was lagging behind, losing in the process more than 750 rubles a month in wages. At this furnace, which systematically did not cope with the planned tasks in 1957, 1958 and in the first half of 1959, A. F. Serkov within a short time, knew how to organize the labor of all four brigades, to impart to the steel workers his own experience and knowledge, to enthuse the people, and as a result to raise sharply the productivity of the unit. Together with this, Serkov did not forget his own former furnace and helped its steel workers with advice and work, because he understood that if the former unit were to decrease in productivity then there would be very little sense in his transfer. The operation of the furnace that previously lagged behind was considerably improved. In the second half of 1959 the collective of this furnace fulfilled the yearly plan by 101.4%.

The struggle for the honorary title of collectives and shock workers of communist labor developed even more widely at the "Krasnyi Oktyabr'" Plant than at the "Serp and Molot" Plant. According to the situation as of January 1, 1960 more than 300 brigades were competiting for this title at the "Krasnyi Oktyabr'" Plant and only 46 at the "Serp and Molot." The Stalingrad metallurgists had ten brigades that were awarded this title and the Moscow had only two. It is necessary to note, however, that at the "Serp and Molot" Plant 27 shifts and one shop participated in this competition, which was not the case at the "Krasnyi Oktyabr'" Plant; this is explained by the weak participation of the engineer-technicians in the competition.

The struggle for the honorary title of brigade or shock worker of communist labor is a good school for educating the Soviet people, especially the young.

These two new forms of socialist competition are not only the most modern but also the most graphic and complete manifestation of the highest stimulus of labor and activity of the Soviet man—the concern for social welfare, for the growth and perfection of social production, the care which organically includes within itself aid to a comrade, the exchange of his experience. This was most clearly demonstrated in the movement of the "Gaganovites," when concern for social welfare, the desire to render aid to those lagging behind, was not halted in spite of personal losses and additional difficulties.

The competition is especially active where there is no formalism, no race for figures. The lack of seriousness in taking and fulfilling obligations, the tolerance of those who disturb the standards in the mode of life and in society, the lack of proper supervision over competition can lead only to harm. The obligations of the collectives struggling

for the title of brigades of communist labor should not be limited to only such points as the overfulfillment of the plan, care of equipment, and discipline in the workshop and in social places. These obligations should provide for aid to the laggards, exchange of experience, an increase in one's own productive-technical level, i.e., everything that is included in the principle "to work, to study, and to live according to communism."

During the 22 years of competition both plants overtook one another many times with new and advanced ideas. However the potentials of the exchange of experience are far from exhausted. This is attested to in particular by the noteworthy initiative of the plant committee of "Krasnyi Oktyabr'" which, for the first time in the experience of the competition, compiled in 1960 a detailed list of the measures put into effect at the "Serp and Molot" Plant and their economic effectiveness if they were applied at the "Krasnyi Oktyabr'" Plant. Certain measures from this list are cited below.

1. Ramming and greasing of chutes with a special mass in order to increase their resistance. The use of this measure at the "Krasnyi Oktyabr'" Plant would make it possible to release 5-6 shift brick layers for work in other sections, increase the resistance of the chutes, and save bricks.

2. Combining the sheet-rolling and temper-rolling mills into one sheet-and-plate rolling shop, which would make it possible to reduce management expenses and improve organization of production.

3. Organization of labor which would permit placing one worker instead of two at the sheet shears. This would increase the productivity of labor and release 14 men.

4. Introduction of a special attachment for laying the sheets in a stack from the back side of a lubricating machine. This would facilitate the work of the stackers and release 5 men.

5. The use of a special machine for dressing stainless-steel sheet bars with emery.

There is still a number of such specific measures on the list.

A mutual exchange of experience by the plants is planned, but these plans sometimes look narrow, faulty. Thus in the plan for the exchange of productive-technical experience in 1959 there were only 11 measures that were worthwhile: there was very little in the plan with which to become familiar and to study concerning the introduction of the most advanced practice. The active practice of the competition far overstepped the frameworks of the exchange of experience as outlined by the plan. Probably if the plan were compiled like the list of measures worked out by the plant committee of "Krasnyi Oktybar'" it would be better. It is the familiarization, and not the end in itself, that is important in the current working order, in the process of preparing for innovations, and this must be the essence of the plan of the exchange of experience.

A more widely developed competition between related shops, brigades, shifts, and individual leading workers would favor the mutual exchange of production and technical experience to a great degree. This reserve is still only slightly used. Of the tens of shops at each plant not more than four or five compete between each other, and the number of brigades competing is even less. Nevertheless it is the competition between related shops and brigades that provides the most direct and rapid exchange of experience.

In 1956-1958 A. Serkov, steel worker at the "Krasnyi Oktyabr'" Plant, competed with Yu. Motorin, steel worker at the "Serp and Molot" Plant. At he end of 1957 Yu. Motorin worked two shifts at the furnace side-by-side with his "rival." During the course of work the individual shortcomings of Serkov, particularly when refining the metal, became quite apparent to Motorin. The friendly advice and comments of Yu. Motorin helped A. Serkov to overcome these faults, which enabled his brigade, during ten months of 1958, to produce in excess of the plan several thousand tons of steel, to smelt 79% of the heats by high-speed methods, to reduce rejects to 0.34% as against the average shop index of 0.52%. Yu. Motorin was very pleased with the organization of labor in A. Serkov's brigade which he himself had employed in order to raise the labor productivity of these steel workers by 12%.

The leading steel worker of "Krasnyi Oktyabr'", Comrade Zar'shchikov, carried out a model smelting in Moscow in 1958 and gave valuable advice for an expeditious method of charging, which had been introduced with success at the "Serp and Molot." Unfortunately, such examples of the competition of brigades, shifts, and sections are few, just as they were in the past.

In spite of the extended experience, the results of the competition between the plants are still summed up rather primitively by a simple calculation of the pluses for the total of the indices taken into consideration. This "method" puts the primary and secondary indices in an equal position, does not account for their overfulfillment by each collective, and sometimes leads to direct errors when the championship is awarded not to the collective that determined the "match" according to the primary indices (cost of production, steel output, rolled goods, productivity of labor) but to the collective that gained the advantage according to the secondary indices.

The shortcomings of such a method of summarizing the results of a competition is still more aggravating in that certain of the basic indices (cost of production, steel output, rolled goods) are compiled not in values relative to the plan or to the number of workers, but in their absolute values (tons, rubles, etc.). When the production volume at plants and the number of workers are different, this inevitably excludes the possibility of a true estimation of the work indices.

The summary of the results of a competition is a review of the achievements of both collectives and should be held in holiday fashion, as a celebration. A general factory meeting should be held not during the dinner

break but in the evening at the House of Technology at the "Krasnyi Oktyabr'" Plant or at the plant club at the Moscow plant; the official part of the gathering should be supplemented by a review of the factory amateur performances. All this will create additional moral stimuli for increasing the efficiency of the competition.

During the 22 years of competition between the Moscow "Serp and Molot" Plant and the Stalingrad "Krasnyi Oktyabr'" Plant an enormous amount of experience has been accumulated in organizing socialist competition between related enterprises. This experience deserves wide dissemination and generalization. The shortcomings noted here do not belittle it, but emphasize factually the inexhaustable possibilities of adopting and introducing all that is the most advanced and new in techniques, technology, in the organization of labor, and in the production at competing enterprises.

REDUCTION OF THE SULFUR CONTENT IN PIG IRON*

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Under the conditions of southern USSR, where blast furnaces operate on sulfurous coke, it is necessary to operate with highly basic slags in order to obtain pig iron with a low sulfur content. This increases the consumption of coke, reduces the output of the furnace, and increases the cost of pig iron. Therefore, I. I. Korobov's conclusions that it is necessary to prepare carefully the charging materials for smelting are entirely correct.

However it is impossible to agree that when smelting with acid slags the hearth is unavoidably cooled due to the low melting heat and melting point of the slags. Heating of the hearth is determined not only by the melting point of the slag but also by its mobility (viscosity). Low-melting, but viscous slags even with a low melting point arrive at the hearth sufficiently heated and do not cause a temperature decrease in the hearth. Thus working with acid, viscous slags cannot cause a decrease in the heat of the lower part of the furnace. This is confirmed by the operation of charcoal furnaces, the hearth heat of which at low (300-400°) blast temperatures was normal.

However, the slags must be viscous in order to assure a uniform working of the large blast furnaces. Acid slags as I. S. Kulikov † pointed out correctly, have a high viscosity even under intense heating. Slags with high basicity also have such properties. As is known, the character of the change in the viscosity of the slag is determined first by the nature of the component crystallizing and by the amount of the mass crystallized. Slags with a small amount of the final liquid phase are viscous and require higher heating. Slags with a large amount of liquid solidifying at a low temperature are more mobile and with relatively little overheating can consist of only one liquid phase.

By examining the crystallization of the primary slags in the system $CaO-FeO-SiO_2$, it is possible to be convinced that acid slag does not always have a poorer viscosity than basic slag.

The figure shows the compositions and melting points of the primary slags for blast furnaces at the following plants: The Magnitogorsk Metallurgical Combine, Cherepovetskii, "Azovstal'", "Zaporozhstal'", and the Dzerzhinskii Plants. These compositions are calculated beginning with the following assumptions:

1) The content of lime in the primary slag is 20% lower than in the final slag due to its incomplete solution at the temperatures present at the bottom of the bosh and stack;

2) The content of silica in the primary slag is 10% lower than in the final slag due to solution of the silica from the coke ashes in the hearth;

3) In the primary slag, the content of ferrous oxide at the instant of its formation is 5-20%.

The compositions of the final slags of the blast furnaces of these plants are shown in Table 1.

Calculations of the quantity of solid initially separated out and the amount of the liquid phase solidifying at low temperature are shown in Table 2.

The results of the calculations show that for the primary slags of the plants in the South the reduction in basicity causes a decrease in quantity of solid initially separated and an increase in the quantity of the liquid phase, i.e., an improvement in the viscosity of the slag.

A further decrease in the basicity of the initial slag in the blast furnaces in the eastern and northwestern sections of the country causes a decline in viscosity. The viscosity of such slags can be decreased by increasing the ferrous oxide content in them. An increase in the ferrous oxide content in the slags of the southern plants assures a decrease in viscosity, but makes the slags unstable.

Operating on slags with a basicity ($CaO:SiO_2$) of 1.0-1.05 does not prevent forced operation of blast furnaces, does not cause cooling of the lower part of the furnace and the production of cold-worked pig iron. Therefore, the problem of desulfurization of pig iron outside of the blast furnace is actual (especially for the southern plants) and requires a solution.

There is also an objection to I. I. Korobov's suggestion about blowing oxygen into the hearth in order to increase the temperature and thus improve the desulfurizing power of the slag. When oxygen is delivered to the hearth

*Response to I. I. Korobov's article "Reduction of the Sulfur Content in Pig Iron during Blast Furnace Smelting."

†Metallurg, No. 12, 1959 [see English translation.]

TABLE 1. Blast Furnace Slags

Plants	Type of pig iron	Composition of final slag, %							Basicity of final slag, CaO: SiO_2
		SiO_2	Al_2O_3	CaO	MgO	MnO	FeO	S	
Dzerzhinskii Plant	Low-manganese open-hearth	38.0	6.49	48.3	4.18	0.66	0.42	1.82	1.28
"Zaporozhstal'"	Open-hearth	38.59	8.40	48.29	1.42	2.42	0.40	1.77	1.25
"Azovstal'"	Phosphorous	37.2	11.58	43.8	2.38	3.34	0.57	2.10	1.17
Magnitogorsk Metallurgical Combine	Low-manganese open-hearth	35.91	15.07	39.64	8.15	0.21	0.23	1.05	1.10
Cherepovskii	Cast	42.97	5.85	45.52	3.33	0.52	0.40	0.64	1.06

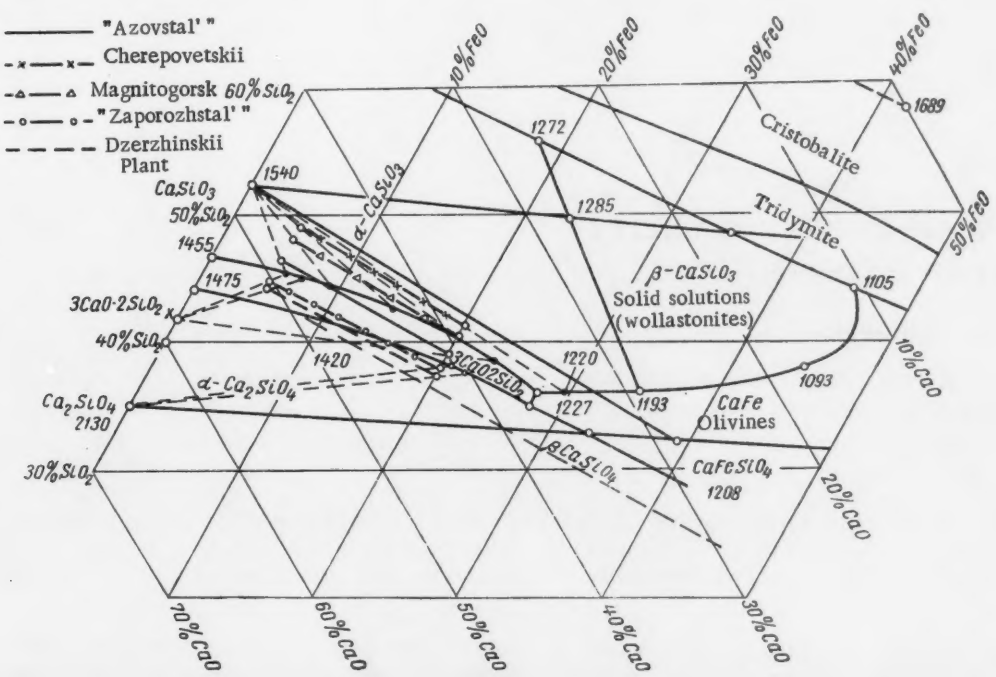
the slag temperature is actually raised due to the oxidation of the iron of the pig. However at the same time the slag will be saturated with ferrous oxide which will impair the desulfurization conditions.

I. S. Kulikov was right when he asserted that the lower the content of ferrous oxide in the slag the better its desulfurizing power is used. Nevertheless it is necessary to note that the cause for the decrease in the ferrous oxide content in the final slag of the blast furnaces at the Magnitogorsk Metallurgical Combine is not the increase in the degree of reduction of the iron oxides at the instant when the formation of slag begins (in other words a decrease of the ferrous oxide content in the initial slag), but the increase in the temperature of the hearth due to the high temperature of the blast.

As investigations showed ferrous oxide is reduced from the slag so quickly that the increased content of ferrous oxide in the final slag can hardly be explained by its high content in the initial slag. The increase in the quantity of ferrous oxide in the final slag impairs the desulfurization process. The desulfurization process will occur at best when the ferrous oxide is most completely reduced from the slag. Ferrous oxide is reduced in the hearth of the blast furnace by the carbon in the fuel according to the reaction:

$$(FeO) + C_{solid} = Fe + CO_{gas}$$

Since the solid carbon is relatively not a strong reducing agent the desulfurization reaction is far from perfect. We therefore consider that the introduction of



Part of the ternary $CaO-SiO_2-FeO$ diagram and the primary slags of certain plants.

TABLE 2. Primary Slags

Plants	Composition of primary slag, %			Basicity of primary slag	Quantity of crystals initially separated out, %	Quantity of liquid phase %	Region of primary crystallization
	SiO_2	CaO	FeO	$CaO : SiO_2$			
Dzerzhinskii	44.8 37.7	50.2 42.3	5.0 20.0	1.13	28.2 8.7	71.8 91.3	Rankinite Larnite
"Zaporozhstal'"	44.5 38.0	50.5 42.0	5.0 20.0	1.10	14.3 2.7	85.9 97.3	Rankinite Larnite
"Azovstal'"	46.4 39.1	48.6 40.9	5.0 20.0	1.05	17.4 13.2	82.6 86.8	Pseudowollastonite Rankinite
Magnitogorsk Metallurgical Combine	48.0 40.3	47.0 39.7	5.0 20.0	0.98	48.4 10.4	51.6 89.6	Pseudowollastonite The same
Cherepovetskii	49.0 41.2	46.0 38.8	5.0 20.0	0.94	67.0 31.8	33.0 68.2	Pseudowollastonite The same

more vigorous reducing agents (aluminum, titanium, calcium carbide, etc.) into the hearth would improve the conditions of reducing ferrous oxide and assure the transfer of sulfur to the slag.

Aluminum, introduced into the hearth, would reduce the ferrous oxide available in the slag according to the reaction:

$$(FeO) + Al = Fe + (Al_2O_3) + 329{,}270 \text{ cal.}$$

This makes it possible to increase the temperature of the slag and to reduce the iron more completely, thus improving the desulfurization conditions.

Thus, to combat sulfur it is necessary to follow two directions: a) to improve the desulfurization conditions in the hearth of the blast furnace and b) to develop a reliable method of desulfurization outside the blast furnace and to change to slags with a basicity of 1.0-1.05.

* * *

AN INCREASE IN THE DURABILITY OF TUYERE FIXTURES

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Translated from Metallurg, No. 5, pp. 9-11, May, 1960

An increase in the durability of tuyere fixtures of blast furnaces is one of the most important problems in pig-iron metallurgy. With the publication of V. V. Poltavets' article the editorial office requests blast-furnace operators to express in the pages of this journal their problems in this field and to relate their experience.

An increase in the temperature of the hot blast to 1100-1200° is one of the most important problems in blast-furnace production. However this is hampered by the inadequate durability of the nozzles. The problems of combatting radiant heat losses through the outside wall of the nozzle and of increasing the mechanical and heat resistances of the nozzles acquire special importance at blast temperatures of 1100-1200°.

Shielded nozzles made of heat-resistant steel were recommended at blast temperatures of 800-950° since their mechanical and heat resistances were satisfactory and radiant heat losses were at a minimum. However at a blast temperature above 1000° the resistance of the shielded nozzles becomes considerably worse. This is especially manifested at the articulated joints of a nozzle having an elbow and flange, because it is impossible to shield the rounded-off ends and sections of the nozzle near these places.

As is known, at certain plants the low durability of the nozzles began to impede an increase in the temperature of the blast although the technological conditions and the heating power of the air heaters made it possible to raise the blast temperature considerably above 1000°.

Blast-furnace operators at certain plants attempted to use various heat-insulating coatings. The best achievements in this direction were attained at the Petrovskii Plant. The coating* used there has high heat-insulating properties but a method still has not been found for making the coating adhere to the wall of the nozzle for any length of time.

In connection with this, the design of a nozzle with a reinforced, insulating coating on the inside wall deserves attention (Fig. 1). A woven, single netting with square mesh (All-Union State Standard 5336-50) is used to reinforce the coating, and this helps the coating to adhere to the inside metallic wall of the nozzle because the outside wire strands of the netting and lubricant itself are lined by the fused metal when casting the nozzle.

The insulating coating contains 80% fire clay which has grain size of 0-2 mm and 20% Chasov-Yar clay. The coating is mixed with water until it is pasty.

The nozzle is manufactured in the following way. The dried core of the nozzle is covered by a single layer of dense moisture-resistant paper along the length of the casting so that the inside surface of the coating is made smooth, which facilitates removing the core from the finished casting. On unwrapping the inside wall of the nozzle the reinforcing netting is inserted, which is placed on the core over the paper so that its flat spirals are arranged along the length of the core.

A layer of damp insulating coating is applied to the netting. The outside strands of the netting should be bare (Fig. 2) in order to grasp the metal of the nozzle during casting. The reinforced coating is dried until all the moisture is removed (maximum temperature is 300°). It is not necessary to "dead burn" the coating before filling with metal since a "dead-burned" coating cannot compensate for the contraction of the metal while cooling, which would lead to the formation of longitudinal cracks in the metallic part of the nozzle.

After drying, the core with the reinforced coating is placed in a flask and filled with metal. The coating is roasted during the casting and while operating the nozzle. The thickness of the nozzle coating depends on the number of the netting selected. For example, in order to manufacture a nozzle with a coating thickness of 18 mm, it is necessary to select No. 40-2.0 netting (40 is the inside mesh size of the netting in mm; 2.0 is the wire diameter in mm).

The metallic part of the nozzle is cast from pig iron or steel. Testing of the sample castings for impact strength, mechanical strength, and heat resistance yielded good results. In order to compare the heat-engineering qualities of ordinary cast pig-iron nozzles and the nozzles with the reinforced, insulating coating the temperatures of the outside walls of the nozzles and the heat losses by radiation were calculated. In the calculations the thickness of the wall of the ordinary pig-iron nozzle was 15 mm, and the nozzle with the reinforced coating was 30 mm (the thickness of the coating was 18 mm and the thickness of the pig-iron wall was 12 mm).

The outside wall temperatures of the nozzles and losses by radiation calculated relative to the temperature of the blast are given in Fig. 3.

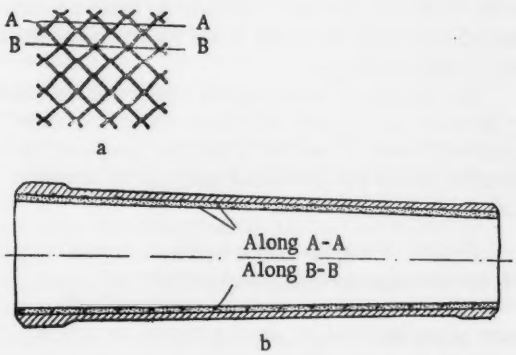

Fig. 1. Tuyere nozzle with reinforced insulating coating: a) reinforcing netting; b) nozzle.

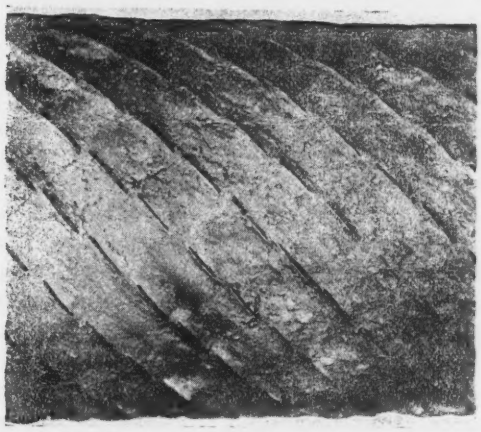

Fig. 2. Core with Coating.

*Metallurg, No. 12, 1959 [see English translation.]

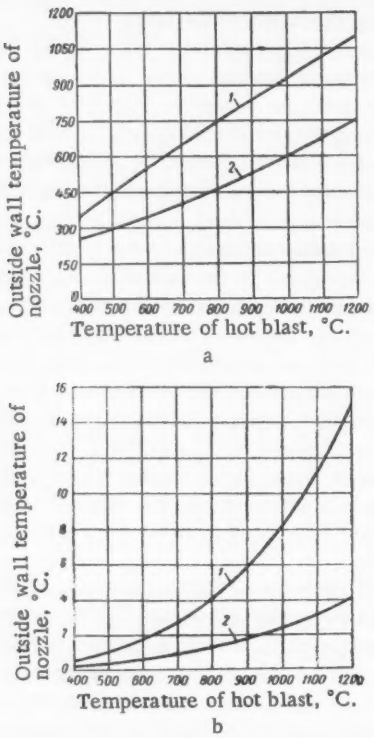
Outside wall temperature of nozzle, °C.
Temperature of hot blast, °C.
a
Outside wall temperature of nozzle, °C.
Temperature of hot blast, °C.
b

Fig. 3. The wall temperature of the nozzle and losses by radiation as a function of the blast temperature: a) wall temperature of nozzle; b) blast temperature; 1) cast pig-iron nozzle; 2) pig-iron nozzle with insulating coating.

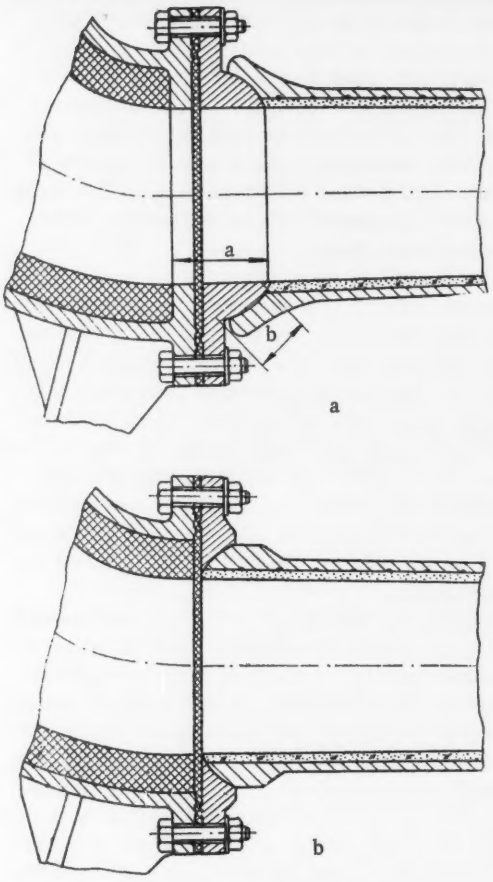

Fig. 4. Connection of the elbow with the nozzle. a) By a convex articulated and, b) by a concave articulated end.

When the temperature of the blast exceeds 1000° it is necessary to take measures to increase the resistance of the articulated joint of nozzle and elbow. Presently, at the majority of blast furnaces the elbow is joined to the nozzle by a convex articulated end of an elbow flange (Fig. 4). Such a joint has substantial shortcomings. The section a, 100-150 mm long, does not have heat protection and the bare metal is subjected to the effect of the high blast temperature.

Circular section b is especially vulnerable. The rim of the end of the nozzle at the elbow does not have heat insulation, as a result of which the rim of the end and the adjacent part of the insulated nozzle are heated to different temperatures. Intense local temperature stresses arise leading to deformation and even cracking at the rim of the nozzle.

When the temperature of the blast exceeds 1000° the metal of the circular section b loses so much mechanical strength that under the effect of the blast pressure [2-2.7 atm (gauge)] it swells.

The method of connecting the elbow with the nozzle by means of the concave articulated end of the elbow flange will make it possible to insulate completely the metallic part of the articulated joint and to increase considerably its resistance.

The use of nozzles with a reinforced insulating coating and articulated joints with a concave articulated end will make it possible to increase considerably the temperature of the hot blast, to attain a greater savings in coke, to reduce the outlay for nozzles, and to improve the labor conditions in the casting yard.

The nozzle described was tested at the Dzerzhinskii Plant.

INCREASING THE SERVICE LIFE OF SKIP-HOIST CABLES

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The All-Union Scientific Research Institute for Ferrous Metallurgy
Translated from Metallurg, No. 5, pp. 11-14,
May, 1960

The service life of skip-hoist cables of the blast furnaces at the Voroshilov, Makeevka, "Azovstal'", and Dzerzhinskii metallurgical plants and the Magnitogorsk Metallurgical Combine varies within wide limits, as is apparent from Table 1.

If we take into consideration that to replace a cable on the skip hoist it is necessary to idle and sometimes even shut down the blast furnace, then it becomes clear how important it is to increase the service life of these cables.

The sizes of the guide sheaves, drums, materials out of which the cables are made, the design of the cables, their proper selection and care, the method of suspending them when replacing, etc., have an effect on the durability of the cables during their use.

Experience shows that the service life of cables operating together with steel sheaves is greater than the service life of the same cables operating together with pig-iron sheaves. However practical data for making conclusions on the advantages of using steel sheaves with a hardened groove surface is definitely inadequate. Literature sources confirm the advantages of using such sheaves. Thus the American investigators assert that with a high hardness of the sheaves a polished wear-resistant shell forms on the rim, in contrast to pulleys made of soft metal which become rough during operation and increase wear of the surface layers of cables.

As is apparent from Table 1, cables of various designs and diameters are used at metallurgical plants for skip hoists. This is chiefly explained by the fact that in the majority of cases when it is necessary to change the cables the same kind of cable is suspended as is at present there. Verified and comparable data on the durability of cables of various designs and sizes is not available, not only for different plants, but also for blast furnaces of the same plant. The Magnitogorsk Mining-Metallurgical Institute together with the workers of the Magnitogorsk Metallurgical Combine investigated the durability of individual designs of cables; however the data of these investigations are inadequate for final conclusions. From this point of view the information on the average service life of skip-hoist cables used at metallurgical plants is of considerable interest (Table 2).

From a comparison of the data in Table 2, we can conclude that cables of design 6 × 19 + 1 langlay (All Union State Standard 2688-55) have a relatively high service life and they should be recommended for use on skip hoists. Such cables are comparatively simple to manufacture, and they can attain a greater increase in efficiency if they are made so they won't untwine. Cables of design 6×36 +1 langlay (All-Union State Standard 7668-55) also should be recommended for greater use on skip hoists. The non-standard 8 × 29 + 1 langlay cables deserve attention even though the number of tested cables of this design is insignificant.

When selecting the cable diameters it is necessary to start from the maximum load on the cable and the factor of safety. A factor of safety of six has been established for skip hoists according to the standards of the State Mining Control Office. The data of the actual factors of safety of skip hoist cables for metallurgical plants are given in Table 3.

From a comparison of data of the metallurgical plants and the State Mining Control Office we can conclude that the rules and calculations which exist for selecting cables are not adhered to at plants when selecting cables for skip hoists, and therefore the diameters of the suspension cables and their factors of safety are increased. It is necessary to keep in mind that with an increase in the factor of safety and a decrease in cable tension the service life of the cable can increase; however its specific efficiency can be decreased. It is apparent from the data of Table 4 that when the factor of safety is increased an increase in the service life is not attained.

The skip-hoist cables at the metallurgical plants are periodically lubricated one or two times a week. The data on the lubricant used for external lubrication of these cables during the course of their operation are given in Table 5.

The cables are lubricated manually: the lubricator pours the lubricant from a bucket onto the sheave, located on the sloping bridge, where the cable runs against it. The cable is not cleaned before lubricating and consequently the fresh layer of lubricant, falling on the dirty lubricant, is mixed with it and also becomes contaminated.

TABLE 1. Service Life of Steel Skip-Hoist Cables

Plants	Diameter of guide sheaves mm	Material of guide sheaves	Characteristics of cables			Service life months
			diameter, mm	Design	All-Union State Standard	
Voroshilov	1800	Cast from steel 45 and pig iron	32.5	6×37+1. TK	3071—55	6.0
			32.0	6×37+1, TLK-O	3079—55	6.7
	2000	Cast from steel 45	41	18×19+1.TK	3088—55	6.9
Makeevka	2000	Cast from steel 45	34.5	6×19+1. LK-R	2688—46	8.3
			32.5	6×37+1. TK	3071—55	5.5
			43.5			4.6
"Azovstal'"	1800	—	36	18×19+1.TK	3088—55	5.8
						7.0
Dzerzhinskii	1800	Cast from steel 2	35	6×19+1. LK-O	3077—55	3.7
			37.5	6×27+1. TLK-O	3078—55	4.8
			41	18×19+ TK	3088—55	4.3
	2000		43.5	6×37+1. TK	3071—55	2.7
						4.0
Magnitogorsk Metallurgical Combine	1600	Cast from steel 45	35			
			33.5	18×19+1 TK	3088—55	5.1
			35.5	6×36+1, LK-RO	7688—55	6.5
	1800	Cast from steel 45	35	6×37+1. TK	3071—55	2.9
			33.5	18×19+1 TK	3088—55	5.2
			35.5	6×36+1. LK-RO	7668—55	7.6

TABLE 2. Service Life of Cables of Various Designs

Cable design	All-Union State Standard	Average life, months
6×19+1***, LK-R	2688—55	7.2
6×36+1***, LK-RO	7668—55	6.9*
18×19+1***, TK	3088—55	5.9
6×37+1***, TK	3071—55	5.5
6×37+1***, TLK-O	3078—55	4.8
6×19+1***, LK-O	3077—55	3.7
8×36+1***, LK-RO	Non-standard, right langlay, nontwisting	5.8
8×29+1***, LK-RO	Regular lay, nontwisting	8.2 (7.1—9.0)** 6.0
6×29+1***, LK-RO	the same	(5.1—6.8)** 6.0
8×25+(7+7), LK-3	Regular lay	(4.2—9.5)**
(18×19+6×7)+1*** LK-RO	Regular lay nontwisting	2 (0.2—3.8)**
18×19+1***, LK-O	Right regular lay	6.7 (4.5—9.8)**
18×19+1***, LK-O	Langlay nontwisting	7 (6.4—7.6)**

* The tables gives the service life of regular cables. The service life of langlay cables of the same design is on the average 8.5 months.

** The maximum and minimum periods are given in the parentheses.

*** Langlay.

Investigations of the contaminated lubricant taken from the skip-hoist cables of the blast-furnace mill at the Magnitogorsk Metallurgical Combine showed that it consisted of 20-25% liquid lubricant and 80-75% solid inclusions. It is clear from this that lubricants in the form which they are used at the majority of metallurgical plants only accomplish their task during the initial operation of the cable and later, as the cable becomes contaminated with solid inclusions, the lubricant not only does not protect the cable from wear but even contributes to premature wear. In order to extend the life of the cables it is first recommended to use a high-quality lubricant and to clean them of contaminated and worked-out lubricant. High-quality lubricant protects the cables from corrosion, helps to decrease friction between the separate wires and between the cable and the sheaves and drum, and also decreases wear from abrasion. The cable grease manufactured at specialized plants by mixing oily asphalt, petroleum bitumen, and petroleum with rosin and graphite (All-Union State Standard 5570-50) corresponds to these specifications.

Under such conditions when for some reason a factory grease is not available a mixture of mineral oil thickened with calcium soap, oily asphalt, and rosin, which is recommended by the Makeevka Scientific Research Institute, can be used. The ratio of the parts of the mixture should be such that at 40-50° it is sufficiently viscous.

It is necessary to introduce mechanized lubricating and cleaning. For example, it is possible to recommend, as an experiment, the method of cleaning and lubricating skip-hoist cables developed by the Magnitogorsk Mining Metallurgical Institute. In order to improve further the processes of lubricating and cleaning, the appropriate institutes, using foreign experience, must continue re-

TABLE 3. The Factors of Safety of Skip-Hoist Cables

Plants	Factors of safety
Enakievo	11–13
Kuybyshev	10–11.4
Il'ich	10.4
Konstantinovka	10–12.3
Stalino	10.2–14.8
"Azovstal'"	9.4–10
Makeevka	8–11
Voroshilov	8–9
Krivoi Rog	10
"Zaporozhstal'"	8–12
Magnitogorsk Metallurgical Combine	7.8–9.4

TABLE 4. Factors of Safety and Service Life of Skip-Hoist Cables

Plant	Cables		Factors of safety	Service life, months
	design	diameter mm		
Voroshilov	6×37+ +1oc langlay	32.5	8–9	6
Enakievo			11–13	3.3
Konstantinovka			10–11.4	7
Makeevka			8–11	5.5

search on developing higher quality domestic lubricants and also simple and reliable mechanisms for cleaning and lubricating.

There are several methods of replacing skip-hoist cables at blast furnaces. These methods have a number of substantial faults:

1) Extending the cable along the railway (Voroshilov Plant, Magnitogorsk Metallurgical Combine) and laying the cable in coils (Makeevka Plant) or zig-zag fashion ("Azovstal'") can ruin the twist and cause contamination of the cables;

2) The method of stretching a new cable by a steam engine through blocks to the drum (the Voroshilov and Dzerzhinskii Plants) is unsuitable since it requires much time;

3) The temporary splicing of a new cable with an old one by cutting out all but two strands for a length to 0.7 m in the new cable and then winding it around and binding it with the old cable, and also by welding the connection places, leads to an irrational loss of cables.

In order to eliminate these shortcomings it is recommended to deliver the new cable to the place where it is to be suspended and to stretch it through the sheaves to the drum by two winches installed on the platform. One of these winches reels off the new cable from the drum and the other one reels on the old cable which is connected to the new one. The splicing method must be changed. In order to connect the old cable to the new one all but two strands should be cut in the old cable (but in no case in the new) and these two strands twisted around the new cable.

New cables should not be stored on drums and in coils in the open for very long since this leads to their corrosion. New cables should be stored in covered places.

TABLE 5. Lubricating Materials for Skip-Hoist Cables

Plants	Lubricating materials
Enakievo Voroshilov Petrovskii Magnitogorsk Metallurgical Combine	Fuel oil
Makeevka Stalino "Azovstal'" "Zaporozhstal'"	Various waste oils
Dzerzhinskii	Oily asphalt
Krivoi Rog	Mineral oil thickened with calcium soap
Konstantinovka	Cable grease
Il'ich	Machine oil
Kuybyshev	Axle oil L

RECONSTRUCTION OF A 20-TON ARC FURNACE

Cand. Tech. Sci. S. G. Voinov and Engineer A. I. Markelov

Translated from Metallurg, No. 5, pp. 15-17,
May, 1960

All electric arc furnaces for steel melting which are used for melting alloy steels both here and abroad have a cylindrical housing. The use of calcined magnesite brick for lining the walls in these furnaces has not increased furnace life chiefly because of the low hot-strength of the refractory materials used.

Because of this, in our country blocks rammed from a mixture of magnesite powder and tar or coal-tar pitch are widely used for lining the walls of electric furnaces.

Abroad, rammed walls of tar and dolomite are chiefly used. In the USA they also use uncalcined chrome-magnesite bricks in iron casings for lining the walls of arc furnaces.

For a lining of rammed magnesite blocks in 20-40 ton furnaces, the wall life is generally in the range 35-60 melts. Because of the low strength of the walls, the slag is enriched in magnesia during melting and this creates technical difficulties, lowers the production capacity of the furnace because of frequent stoppages for repair, and increases the consumption of refractory materials and electric energy. The different measures, directed to speeding up the repair of arc furnace linings (mechanized demolition of the old walls, demountable furnace casing, etc.) do not increase the life of the wall lining.

Therefore, to increase the life of the wall lining, modifications to the sloping walls in arc furnaces, such as the rear walls of open-hearth furnaces, have been suggested in the past.

At the end of 1936 in one factory on a 3.0-ton arc furnace in an experimental series of casings, a furnace was prepared in the form of a cone, wider at the top. However, the inclination of the generatrix of the cone was small because of misgivings about the considerable increase in roof diameter. Because of this, the inclination to the vertical of the inside surface of the wall lining was always 14°. Nonetheless, under these conditions the wall life was substantially increased.

In 1954-55, under the initiative of Cand. Tech. Sci. A. I. Kholodov, the casings on 15- and 20-ton furnaces were made conical, so that it became possible for the inclination of the inside surface of the refractory wall lining to be up to 19°. Working experience on these furnaces also showed substantial benefits in wall life and in furnace production capacity.

According to a project conceived by S. G. Voinov, A. I. Markelov, E. K. Miller, and A. F. Turomyshev, in 1959 a 20-ton arc furnace of one factory was rebuilt, the vertical walls being replaced by partly inclined-partly vertical walls (Fig. 1, 2). The chief dimensions of the furnace are shown below.

	Before rebuilding	After rebuilding
Internal diameter of casing, mm:		
at the level of banks	4,300	4,460
at the level of the top of the vertical section	–	4,710
Bath-diameter at level of the banks, mm	2,980	3,220
Height of walls up to roof abutments, mm	1,100	1,100
Inclination of conical section of casing to vertical, deg	–	14
Height of the conical part of the casing, mm	–	820

As can be seen from the figures given, the new furnace differs from the old in the following ways: the internal surface of the furnace walls (refractory lining) is inclined to the vertical at an angle of 39° instead of 12° before reconstruction; the furnace casing, as distinct from the ordinary cylindrical casing or conical casing having an increasing diameter towards the top, is made as a combined unit, the lower section being conical broadening toward the top, and the upper section being cylindrical; the bath diameter at bank level is increased by 240 mm.

The new furnace with the inclined-vertical walls has the following advantages:

1) The refractory wall lining being inclined at approximately 40°, will be considerably less attacked, since it rests on the furnace body and because of this it possesses increased stability.

2) As is well known, at the slag level a region of the furnace wall is eroded and this is the reason for carrying out repairs regularly. With the inclined-vertical walls, their hot repair at the slag level is considerably facilitated, since the magnesite powder or other dressing material does not slide off so readily as with vertical walls.

3) The furnace walls are further away from the arc zone and therefore less attacked by the arc action.

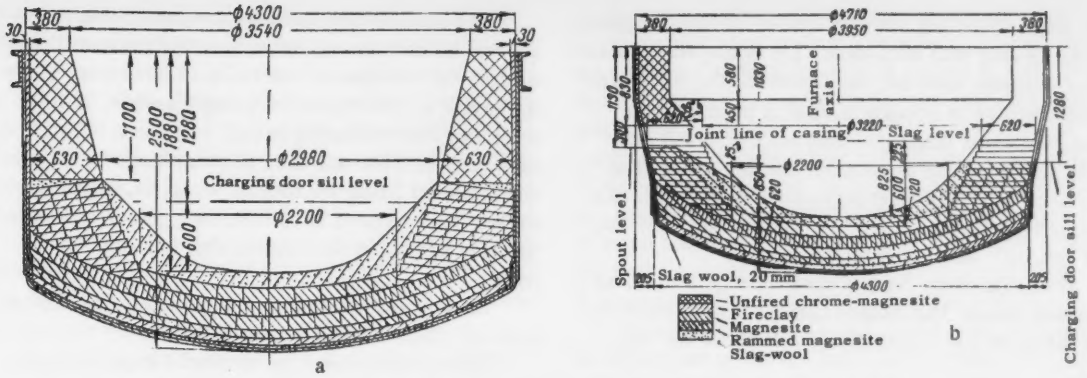

Fig. 1. Section of arc furnace. a) Before reconstruction b) After reconstruction.

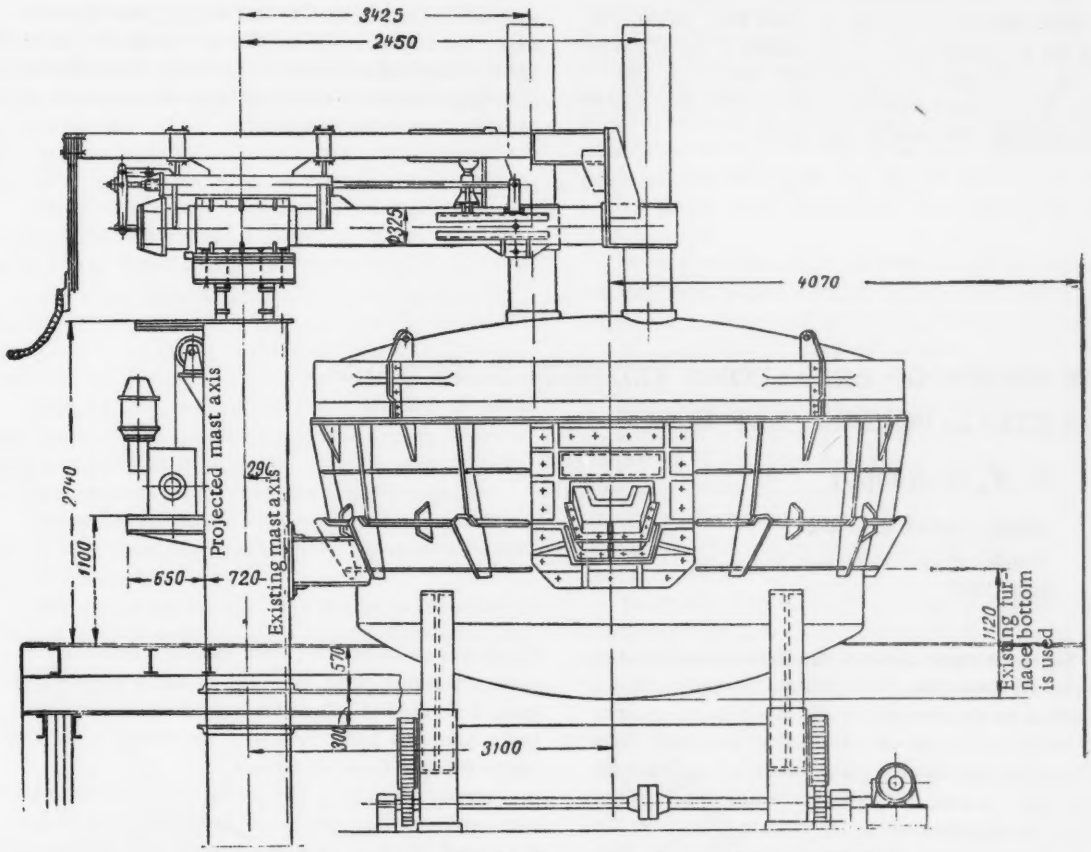

Fig. 2. External appearance of the 20-ton arc furnace after reconstruction.

4) The larger bath volume makes it possible to have a lower slag level with the same charge and consequently also it becomes more easy to pour the melt and slag into the ladle—this is very important for removing sulfur and nonmetallic inclusions from the metal.

5) With the greater resistance of the furnace walls the slag is less contaminated with magnesia and, hence, it has better physicochemical properties.

6) With the substantial increase in wall life, stoppages on the furnace for repair are reduced, production capacity is increased and the specific consumption of refractories and electrical energy is decreased.

In rebuilding the arc furnace, apart from the change in the principal dimensions of its working volume and the replacement of vertical by inclined-vertical walls, the refractory material of the walls was changed. These

were made of 300 and 430 mm unfired chrome-magnesite bricks, armored with steel sheet. The bricks were prepared by the Kuznetsk Metallurgical Combine. The bricks were stacked on edge in separate rings with overlap of the joints. The lower three rows were built from 430 mm bricks, and the upper layers from 300 mm bricks. The number of unfired chrome-magnesite bricks used in one relining were for the 1st row, 110 bricks; 2nd, 114; 3rd, 116; 4th, 122; 5th, 124; 6th, 145.

The banks of the furnace were built up from ordinary magnesite bricks. The furnace casing has been made demountable (at approximately 100 mm above the slag line).

The production capacity of the furnace after reconstruction was considerably increased.

The wall life (averaging five months) has become 170 melts instead of 55 melts as it had been before. The time lost on lining repair in five months of furnace working was 1.65% instead of 3.0% before rebuilding. The yearly furnace production capacity has been increased by approximately 1500 tons of alloy steel.

As a result of the reconstruction, according to our figures, substantial economies have been obtained, namely: a) from the reduction in lost time, 53,424 rubles; b) from the saving in refractories for lining the walls, 28,284 rubles; c) from the saving in roof brickwork, 13,014 rubles; d) from the reduction in consumption of magnesite bricks for lining the furnace banks, 25,950 rubles; e) from the reduction in electric energy used in the preliminary heating of the furnace after relining, 7,164 rubles.

Thus, in all, the yearly saving on the furnace stood at about 128,000 rubles.

Taking into account the successful experience of rebuilding the 20-ton arc furnace, the factory has planned to modify two more 20-ton arc furnaces in 1960.

The successful experience on rebuilding an arc furnace and replacing the vertical walls by sloping ones should be recommended to other factories. The planning and building organizations, in particular OKB Élektropech', must take account of this experience in planning new arc furnaces for steel melting.

* * *

THE CAUSES OF BREAKDOWN AND REPAIR METHODS FOR STEEL-POURING TAP-HOLES

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Tap-hole repair is one of the most labor-consuming and crucial operations. A long hearth campaign has a bad effect on the condition of the tap-hole: it becomes very badly eroded and the brickwork of the lining becomes impregnated with furnace scale, which all increases the repair time. In turn, this prolongs the hearth repair, since without having prepared the tap-hole to drain away the excess of molten slag, it is impossible to begin the formation of slag on the working layer of the hearth.

The rate of flow of metal and slag and the volume of them remaining on the hearth depend on the condition of the tap-hole.

The brickwork of the lining and the burned-in section of the tap-hole are eroded during pouring. Fusion of the upper burned-in section of the tap-hole can be caused by a high fluorspar content in the refractory mixtures used to repair it. The configuration of the steel-pouring tap-hole can also change because of the appearance of protuberances on its bottom; these form as a result of incorrect covering of the tap-hole, so that a magnesious paste is allowed to fall on the bottom and adheres to it in the form of a dam, preventing the normal outflow of metal and slag from the furnace.

During the burning-out of slag and metal residues with compressed oxygen or air (at a pressure of 5 atm) the burned-in layer is strongly eroded; this involves the deformation of that section which joins the working volume of the furnace.

The Eastern Refractories Institute has investigated hearth service conditions on open-hearth furnaces at the Chelyabinsk Metallurgical Factory (ChMZ) and at the Nizhne-Tagilsk and Kuznetsk Metallurgical Combines (NTMK and KMK). In these investigations observations were made on the tap-hole repair schedule and the condition of the tap-hole in working and before repair, and the composition of the refractory charges used for restor-

ing the working profile of the tap-hole was established. These observations indicated that the life of the steel-pouring tap-hole at ChMZ was considerably lower than at KMK or NTMK. Despite the lower working period of the tap-hole at ChMZ (17-20 melts), the deterioration, and consequently the duration of repair, was considerably greater than at KMK and NTMK, where tap-hole repair is carried out after 25-40 melts.

One of the causes of the more intense erosion of the steel-pouring tap-hole at ChMZ as compared with KMK and NTMK is the prolonged burning-off of the slag-metal residues; in this process the tap-hole is considerably eroded, and to restore its designed dimensions a larger amount of materials, labor and time is required.

In most cases during tap-hole repair it is necessary to chip off part of the brick lining of the rear wall; metal penetrating into joints in the brickwork and reinforcing it on cooling makes this extremely difficult. The penetration of metal into joints of the tap-hole lining can arise from a number of causes: ill-timed repair of the burned-in section; poor quality completion of the brick lining; the use of a coarse filler in the mortar and the use of a mortar with a high shrinkage on firing.

Chipping away the worked-out brick lining to a depth of 700-800 mm takes up to 1 hr 30 min at KMK, up to 1 hr at NTMK and up to 3 hr at ChMZ.

The longer time taken at ChMZ in chipping away the brick lining is caused by the penetration of metal into joints in the lining on the whole width of the rear wall and into 2-4 bricks around the tap-hole channel.

The different working conditions, the service period and the type of maintenance on steel-pouring tap-holes lead to the formation of various defects, the correction of which requires different measures and materials.

Below are set out the most widely occurring forms of tap-hole deterioration together with the causes of erosion, and repair methods.

Bending of the tap-hole axis occurs by deposition on its bottom of dressing materials (Fig. 1). Highly refractory dressing materials adhering and not becoming molten in the melting process, form a protuberance which hinders the outflow of metal. The moving stream of metal, being diverted off from the protuberance can erode the upper part of the tap-hole as shown in Fig. 1. Such erosion contributes to the restoration of the active cross section of the tap-hole; however its axis will then be bent and the protuberance left will hinder the complete removal of metal and slag from the furnace. Protuberances forming on the bottom of the tap-hole are cut away with compressed oxygen from the pouring-aperture side.

Because of the erosive action of the slag and metal, the upper part of the tap-hole can be washed away in the region of the burned-in section of the back wall (Fig. 2). Such erosion is favored by high slag or clay content, introduced in the paste used in repairing the tap-hole. With this type of deterioration, repair consists in carrying out the following operations during the burning-in of the hearth: the steelworker first levels off the bottom of the tap-hole and chips away all worked-out lining; then a templet, either a metal tube or a small wooden block, is placed into the tap-hole, which has been well cleaned of metal and slag blockages. The templet diameter is 150 mm for single-spout furnaces, and 150-200 mm for twin-spout furnaces.

Having put the templet in position, the steelworker and his helpers build up a dam of magnesite powder or unfired dolomite in front of it on the furnace aperture side to cover the end face of the templet. Sometimes, instead of a templet a barrier is built up of powder (Fig. 2). Then, in both cases, the top of the tap-hole is built up, a mixture containing 75% metallurgical magnesite powder and 25% slag being thrown on through the central charging window. The brickwork lining that had been chipped out is replaced by new lining, and in doing so special attention is paid to the care with which the brickwork is executed.

If not only a section of the burned-in arch of the pouring aperture is eroded, but also the brick lining (Fig. 3), then complete restoration of the aperture profile to its designed dimensions by building-up from the bath

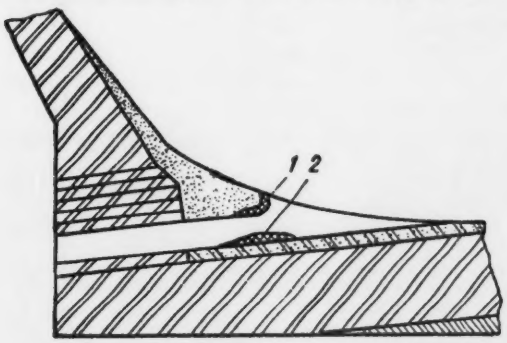

Fig. 1. Bending of the tap-hole axis as a result of dressing materials adhering to its bottom. 1) Part of the burned-in lining of the tap-hole washed away by slag and metal; 2) dressing materials adhering to the tap-hole bottom.

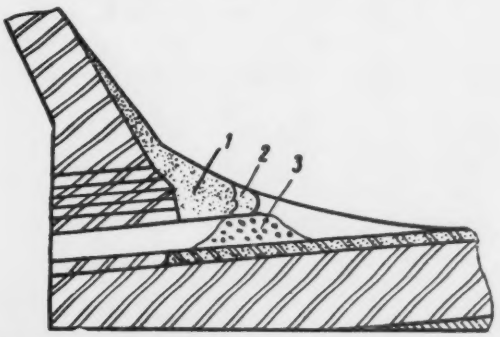

Fig. 2. Erosion of the top of the tap-hole on the bath side. 1) Burned-in lining intact; 2) fresh burned-in lining; 3) plug of magnesite powder or raw dolomite.

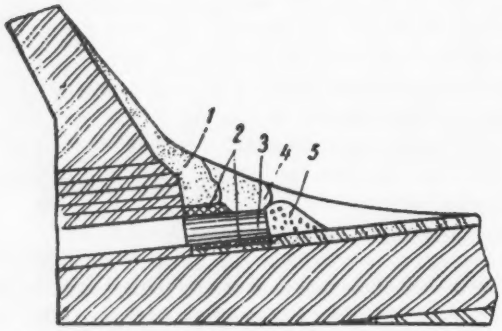

Fig. 3. Erosion of the burned-in section of the tap-hole reaching the brick lining. 1) Burned-in lining intact; 2) rammed material; 3) templet; 4) fresh burned-in lining; 5) plug of magnesite powder or raw dolomite.

side becomes impossible. In this case the design aperture profile is obtained by combining building-up of the tap-hole from the bath side with ramming its wall from the pouring-aperture with a moist paste consisting of 85-90% magnesite powder and 10-15% refractory clay. As in the preceding case, a templet is laid on the bottom of the tap-hole, which is previously cleaned of metal and slag blockages and levelled off with magnesite powder; in front of the templet, from the furnace-aperture side, a barrier is built up from magnesite powder or unburnt dolomite. The gap between the templet and the walls is completely rammed with a moistened mixture of magnesite powder and 10-15% refractory clay. On completion of ramming the tap-hole from the spout side, the building-up of the top of the tap-hole is started from the bath side, and this is carried out in layers until the working dimensions of the tap-hole are completely restored. Building-up is carried out with a mixture of magnesite powder and 25% slag. Before pouring off the excess of molten slag, formed after the slagging-off of the freshly burned-in hearth layer, the magnesite powder or dolomite covering the end-face of the templet is raked away and the baked-on crust is pierced with a poker or burned through with oxygen. In charging free-flowing materials the tap-hole, irrespective of the method used for its repair, is covered with a layer of ore. After repair it should always have a slope down to the pouring-aperture side.

In all types of repair the dressing materials (mixtures of magnesite powder with clay or slag) must not be allowed to fall on the bottom of the tap-hole nor must the disposition of the bottom of the tap-hole be above the level of the furnace hearth, since protuberances appearing on the bottom because of adherent material, or a wrongly-sloping aperture bottom, prevent the complete removal of metal and slag from the furnace. Stagnant pockets of slag formed on the hearth lead to the appearance of pits, and this necessitates shut-down of the furnace for hearth repair.

During hearth repair the tap-hole is kept uncovered so that dressing materials falling on the tap-hole bottom may be removed through it while a layer is put down on the hearth.

To prevent fusion of the top of the tap-hole on the bath side, the slag content should not exceed 25%, but if refractory clay is used as an addition, its content should not be greater than 15%.

With a view to preventing impregnation of the tap-hole brick-work refractory the horizontal and vertical joints should be completely filled up with mortar-paste. The mortar-powder used for preparing the mortar-paste should be not coarser than 2 mm. Magnesite or chrome-magnesite powders, obtained by crushing and grinding old chrome-magnesite or magnesite bricks under the hammer, must be regarded as the best mortar-powders.

To avoid the formation of unfilled joints in the lining, the refractory clay content in the mortar-powder should not exceed 25-30%, since in using a mortar-powder with a higher clay content considerable shrinkage occurs.

All the repair methods described above for steel-pouring tap-holes are used at the moment at NTMK, KMK and the Chelyabinsk Metallurgical Factory. Differences exist only in the duration of repair, which depends on the degree of deterioration of the steel-pouring tap-hole; this, in its turn, is determined by the care taken in carrying out the repair, the composition of the repair mixtures and melt-to-melt maintenance of the tap-hole.

* * *

A NEW DESIGN OF AN ELECTRODE-HOLDER BLOCK FOR ARC FURNACES

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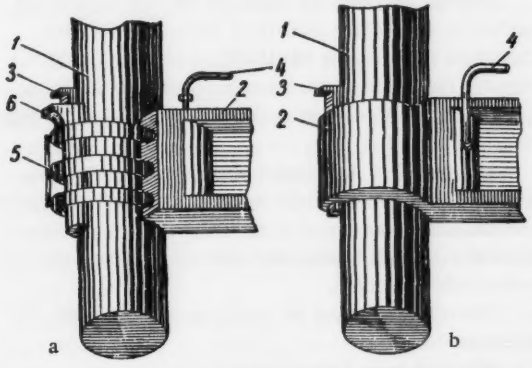
In the foundry shop at the Elektrotyazhmash plant, two acid-lined electric arc steel-melting furnaces are being worked for melting carbon steels. The weight of a melt is 6-8 tons. The furnaces are equipped with electrode holders in which the electrode is wedge-clamped.

The front part of the electrode holder block is made in the form of water-cooled pipes, to which is welded the socket with the inserted wedge (see figure).

Working experience in the shop over six years has indicated that the design of an all-copper electrode-holder block with water-cooled pipes is not satisfactory since, in clamping and unclamping the electrode, the pipes deform and spring leaks, and this leads to long furnace hold-ups. Moreover, wedge-sockets have to be replaced periodically because they become deformed, and this also gives rise to lost furnace time.

With the aims of reducing lost time and saving red copper, on one furnace an electrode-holder block was installed with a single piece cast-steel body and a brass bush.



Wedge-clamping of an electrode in electrode-holder blocks. a) old design; b) new design. 1) electrode; 2) electrode-holder block; 3) wedge; 4) water pipe; 5) pipes; 6) wedge socket.

This was to the KhTZ type of block design, with the difference that in the block used at the Elektrotyazhmash factory the copper insert was replaced by brass. To reduce the electric resistance, and consequently the consumption of electric energy, in the new electrode-holder block the volume of the water-cooled cavity was increased (6,500 cm^3 instead of 4,800 cm^3).

Moreover, in the new block, considerably less copper is used; whereas the weight of copper in the old block was 270 kg, the brass insert weighs in all 55 kg (that is, about 45 kg of copper).

From 40 melts average figures are shown below for melt duration and consumption of electrical energy per ton of steel.

	Electrode-holder design	
	old	new
Average melt duration, hr-min	3-58	3-54
Average specific consumption of electrical energy, kw-hr/ton	708	692

As can be seen from these figures, the use of the new design block results in a slight reduction in the consumption of electrical energy; the melt duration and the average melt weight remain the same.

Thus the electrode-holder block set up on furnace DS-5M, having a single-piece cast-steel body, brass bush and a water-cooled cavity of increased volume is economical, reliable in use and makes it possible to reduce somewhat the consumption of electric energy.

Editorial Note. The block design described can be used only on furnaces where the electrode is wedge-clamped—that is, on small furnaces of old design. Now electrode-holder blocks have been developed and are becoming common on large furnaces which have a weld-deposit of alloy MTs-4 or chromium bronze on the contact surface.

* * *

NEW METHOD OF LUBRICATING MOLDS BY USING PETROLATUM

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Zlatoust Metallurgical Plant, Chelyabinsk Polytechnical Institute
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May, 1960

The production of ingots with a smooth surface is one of the basic problems in the process of teeming steel. The surface quality of ingots depends on many technological factors of melting and teeming.

In order to produce alloy steel ingots with a good surface it is necessary to ensure two basic requirements of teeming—optimum operation conditions and the creation of a reducing or neutral atmosphere over the surface of the metal.

The use of argon or carbon tetrachloride for displacing the air from the inside cavity of the mold solves only one part of the problem—the creation of a neutral atmosphere. Because of the lack of lubricant on the walls the molds rapidly crack and fail and the surface of the ingots deteriorates. The use of CCl_4 impairs the working conditions.

At the Zlatoust Metallurgical Plant a new method of lubricating molds when teeming steel has been developed and introduced into production; this method ensures the necessary conditions for the work of the lubricant and at the same time creates a reducing atmosphere over the surface of the liquid metal.

The method is as follows:

Before starting to teem, pieces of dehydrated petrolatum (paraffin and other cheap organic substances can be used in addition to petrolatum) are thrown into the bottom of the unlubricated molds. Due to the low melting point the petrolatum in the mold at first melts and flows along the surface of the rising liquid metal and then volatilizes, and its vapors begin to burn intensely.

As a result of the lack of oxygen in the mold (the mold is capped) reducing gases are formed over the metal and sooty carbon is deposited as a uniform layer about 0.5 mm thick* on the inside walls of the mold. The uniform deposit of sooty carbon and the presence of a reducing atmosphere over the surface of the metal ensures the production of good ingot surfaces.

The new mold lubricant was tested while teeming stainless and chromium steels.

Stainless steels with a high content of chromium in the liquid state are distinguished by high viscosity and easily react with the oxygen in the air, forming high-melting oxide films. In one degree or another this phenomenon is observed while teeming all chromium steels. The optimum operating conditions of the mold lubricant are especially difficult to select for such steels. When teeming certain stainless steels a reducing atmosphere is produced in the mold due to carbon tetrachloride vapors.

TABLE 1. Composition in the Gas Phase in a Mold when Teeming Steel 1Kh18N9T

Lubricant	Average chemical composition, %					
	CO_2	CO	O_2	H_2	CH_4	C_nH_m
Petrolatum	1.18	7.83	1.93	22.86	5.26	5.80
Carbon tetrachloride	4.30	4.40	9.00	—	0.42	—

In order to check the effect of the new lubricating method on the surface quality of ingots, stainless and chromium steels (types 1Kh18N9T, 12Kh5MA, Kh9C2, 3Kh13, 4Kh13, etc.) were teemed into ingots weighing 2.7 tons both with carbon tetrachloride and with the usual lubricant.

The pieces of dehydrated petrolatum were thrown into the molds immediately before teeming. Its expenditure was 0.3 kg per ton of liquid steel. The molds were cleaned with steel brushes and covered with pig-iron covers before teeming.

The temperature of the molds as a rule was 60-120° before teeming.

The metal was bottom poured.

The use of petrolatum when teeming steel ensured "self-lubrication" of the inside walls of the mold. An analysis of gas samples taken from the inside cavity of the mold during the teeming process showed the presence of an acute reducing atmosphere over the surface of the rising metal (Table 1).

It is apparent from Table 1 that the gas phase in a mold when teeming with petrolatum contains a small amount of oxygen and a considerable amount of reducing gases.

* The thickness of the sooty carbon layer depends on the amount of petrolatum and rate of teeming.

TABLE 2. Hydrogen Content in Metal of Experimental and Ordinary Ingots

Brand of steel	Lubricant	Number of determinations	H_2 content, average	$cm^3/100$ g fluctation
1Kh18N9T	Petrolatum	5	6.26	4.98–7.02
	Carbon tetrachloride	10	6.74	6.5–7.02
Kh9S2	Petrolatum	5	5.08	4.18–6.35
	Lakol'*	–	–	–
1Kh13-4Kh13	Petrolatum	6	5.98	4.14–9.82
	Lakol'*	4	7.09	6.04–8.12
12Kh5MA	Petrolatum	3	6.03	3.88–7.29
	Lakol'*	2	4.17	4.12–4.23
7Kh3	Petrolatum	3	7.24	6.58–8.38
	Lakol'*	1	5.41	5.41
ShKh15	Petrolatum	5	5.00	3.07–6.14
	Lakol *	–	–	–

*Solution of polymerized and unsaturated hydrocarbons in solvent naphtha + rosin.

TABLE 3. Carbon Content in Surface Layers of Blooms Made of Steel 1Kh18N9T Cast with the Use of Petrolatum

Tentative numbers of heats	Carbon content, %			
	in forged specimen	in blooms		
		Specimen A	Specimen B	Specimen Kh
001	0.09	0.08	0.08	0.07
002	0.07	0.08	0.08	0.08
003	0.12	0.11	0.11	0.10

The hydrogen content in the metal of the experimental heats was determined with consideration of the high hydrogen content in gases when teeming steel with petrolatum. Samples of liquid metal were drawn into a quartz tube from the riser of the ingot. The hydrogen content in the metal of the heats cast with petrolatum is at the usual level (Table 2). In a number of cases the hydrogen content was less for the experimental heats than for the usual heats.

The results of checking the possibility of carburizing the surface layers of metal by the carbon deposited on the inside surface of the molds did not show a difference in the carbon content in rolled metal as compared with a corresponding forged sample (Table 3).

It was experimentally established that the use of petrolatum when teeming stainless steel 1Kh18N9T increases the durability of the molds. Thus the average durability of 24 molds for ingots weighing 2.7 tons with the use of petrolatum was 18 heats (with the lowest durability being 12 and the greatest 29) as against 8-7 in the same molds with the use of carbon tetrachloride.

The new technology of teeming with the use of petrolatum ensures smooth ingot surfaces. This is especially apparent for ingots of steel type 1Kh18N9T during the

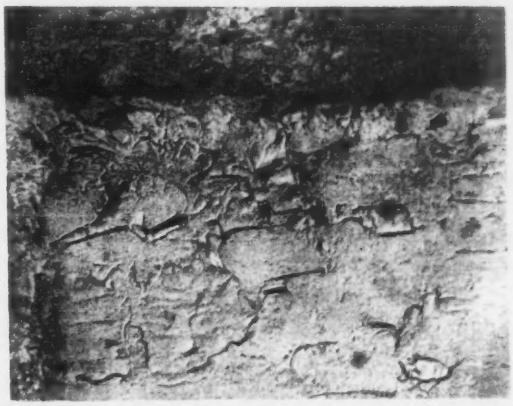

Fig. 1. Films being formed in the upper part of the ingot weighing 2.7 tons of steel 1Kh18N9T teemed with the use of carbon tetrachloride.

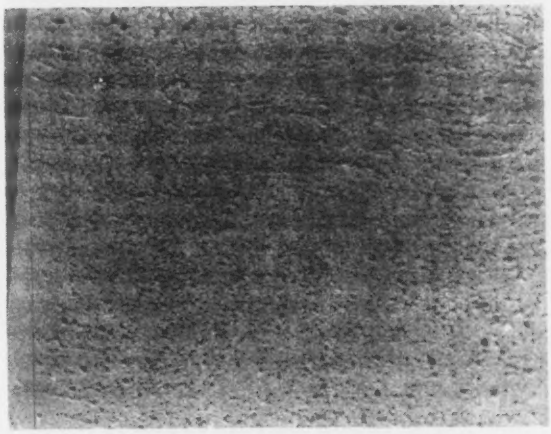

Fig. 2. Surface of 2.7-ton ingot of steel 1Kh18N9T cast with the use of petrolatum.

TABLE 4. Comparative Results of Rejects of Heats of Different Steels

Type of steel	Method of teeming	Number of heats	Rejection of blooms due to surface defects		Rejects, % of those cast			Comments
			I+II category	III category	due to surface defects	due to macrostructure	Total	
12Kh5MA	With petrolatum	3	100	—	1.64	—	1.64	Rejection of the blooms in the first conversion
	Ordinary	3	97.0	3.0	2.1	—	2.1	
ShKh6	With petrolatum	20	91.4	8.6	0.16	0.54	0.7	Rejection of rods in the second conversion
	Ordinary	25	87.6	12.4	0.84	0.49	1.33	
ShKh15	With petrolatum	21	92.0	8.0	0.25	0.15	0.40	Rejection of the blooms in the first conversion
	Ordinary	29	83.0	17.0	0.50	0.06	0.56	
Kh9S2	With petrolatum	22	28.1	71.9	0.42	0.03	0.45	Rejection of rods in the second conversion
	Ordinary	37	22.2	77.8	0.55	—	0.55	
3Kh13-4Kh13	With petrolatum	23	91.8	8.2	0.06	—	0.06	The same
	Ordinary	25	97.8	2.2	1.18	0.07	1.25	
1Kh18N9T According to GOST*	With petrolatum	6	—	—	—	0.91	0.91	—
	Ordinary	11	—	—	0.90	2.8	3.7	
1Kh18N9T Acc. to Tech. Spec. 752**	With petrolatum	21	—	—	0.40	0.55	0.95	—
	Ordinary	12	—	—	0.45	0.69	1.14	

* 1Kh18N9T steel ingots, delivered according to the All-Union State Standard, go through snagging and also blanks delivered in conformity with Technical Specification No. 752. Ingots in the latter case are not subjected to snagging.

** The surface quality of 1Kh18N9T steel blooms adjusted for the rolling-mill shops is not estimated.

teeming of which a smooth surface is not always produced with the use of carbon tetrachloride (Figs. 1, 2).

The data in Table 4 show that the new lubrication method helps to improve the surface of ingots, blooms, and blanks. The quality of the macrostructure of the experimental heats does not differ from the ordinary heats.

Careful surpervision of steels susceptible to flocculation did not reveal this defect in a single heat cast with petrolatum and further treated according to the present technology. A check of the mechanical properties of the finished metal did not show a deterioration in these properties when using the new lubricating method. Testing of the metal of the experimental heats of type 1Kh18N9T steel for the presence of intercrystalline corrosion in them also yielded satisfactory results.

The broad experiments on the use of the new method of lubricating molds with petrolatum when pouring killed steel permit the following conclusions:

1. The use of petrolatum ensures good surfaces on ingots and rolled metal, especially when teeming stainless steels (1Kh18N9T, 1-4Kh13, Kh9S2, etc.); it reduces the rejection of metal due to surface defects.

2. The new method of lubricating molds does not impair the macrostructure and the mechanical properties of steel. The amount of hydrogen in the liquid metal is at the usual level.

3. The use of petrolatum does not cause any difficulties; it considerably reduces labor-consuming operations connected with the preparation of molds for teeming, improves the labor conditions of the workers as compared to teeming with the use of carbon tetrachloride.

* * *

AN EXPERIMENT IN INCREASING THE LIFTING CAPACITY OF THE POURING SIDE CRANE

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More than 20 years ago a 175-ton pouring side crane manufactured by the Ural Machine Building Plant was installed in the open-hearth mill at the Nizhne Tagil' Metallurgical Combine.

With an increase in the charge of open-hearth furnaces it became necessary to increase the lifting capacity of the crane to 200 tons. We decided to reconstruct the crane by our own efforts without lowering the bridge from the crane runways.

It was necessary to accomplish the following operations while reconstructing the crane: To reinforce the main bridge girders; to change the mechanism of the main hoist; to reconstruct the rocker arms of the travelling crane mechanism because of their conversion to rolling-contact bearings.

The bridge of the crane is a riveted metal structure with two main and two auxilliary box section girders.

The designers of the Office of the Chief Mechanic of the Nizhne Tagil' Metallurgical Combine in conjunction with the scientific workers of the S. M. Kirov Ural Polytechnical Institute made the necessary calculations, on the basis of which the drawings for strengthening the main girders of the crane bridge were worked out at the Combine. In order to reinforce the lower booms of the main bridge girders the 22-mm diameter rivets were replaced by new ones having a diameter of 25 mm; the 18- and 14-mm plates on the lower booms of the main girders were replaced by plates 26- and 18-mm thick.

Before beginning modernization, the crane was installed between the second and third furnaces in the mill, the main and auxiliary cars of the crane were placed at the extreme position on the bridge, and the main girders of the bridge were levelled.

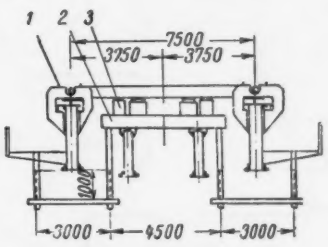
Both cars were than disassembled and lowered so that the crane bridge could be shifted to the side, and then it was again placed between the second and third furnaces. The bridge travelling mechanism was also disassembled and lowered. After this we made a vertical angulation of the main and auxiliary girders. The supporting structures were suspended at the same time as the levelling.

In order to reconstruct the travelling mechanism we raised the bridge by means of special lifting jacks and levelled it. The cabin was freely suspended from the bridge, after which its attachments to the lower booms of the main bridge girders were dismantled.

This ended the preparatory work. The rivets were cut away on the lower booms of the main girders, the plates of the lower booms were lowered and used as patterns for drilling holes in the new, thicker plates.

Since the reconstruction of the bridge made it freely suspended, considerable stresses could arise from the weight itself and from deformation in the elements of its main girders. In order to avoid this we installed special weight-relieving devices (figure). On the upper booms of the main girders we secured two special girders with two cantilever brackets and under them two girders on the upper booms of the main girders we secured two special girders with two cantilever brackets and under them two girders on the upper booms of the auxilliary girders. We placed hydraulic jacks and special supports between the girders.

The position of the check points was checked by levelling. The main girders of the bridge were relieved of weight by jacks to the calculated values. The new plates of the lower booms were put in place and bolted, after which we made holes and riveted the lower booms of the main girders.



Weight-relieving device of the pouring side crane: 1) upper girders; 2) lower girders; 3) supports.

The jacks and supports made it possible to assure the necessary structural lift in the main girders.

The experiment showed that riveting of the plates should begin in the center of the bridge and gradually work to the edges.

After fastening the lower carriages on the upper booms of the main girders the old cover plates were removed and new ones attached.

We inspected the bridge in order to check the quality of the riveting. We replaced the rejected rivets before the lower boom plates of the main bridge girders were installed and fastened.

During the work we systematically levelled the main and auxiliary girders and controlled the stresses by the jacks.

When riveting of the bridge was completed it was lowered to the crane runways, the weight-relieving device was removed, and a final levelling made. Then both cars were installed on the bridge and the bridge drive mechanism assembled.

Since the reriveting was done on a freely suspended bridge and there was no prior experience at the Combine on reriveting such heavily loaded cranes, a number of questions naturally arose in connection with determining the actual stresses in the elements of the main girders after their alterations and with the work of the individual plates of the lower boom. It was not possible to solve these problems by theoretical calculations. Therefore, experimental investigations of the operation of the bridge were made under production conditions.

We experimentally determined by strain measurements the tension values in the various sections of the metal structure of the main bridge girders of the pouring side crane.

On the basis of these measurements and also of the calculations made of these girders it was established that stresses in the component plates and corner brackets of the lower booms of the main bridge girders are comparatively low ($\sigma_{\text{tensile stress}} = 754\text{-}716$ kg/cm^2), the load in the lower booms of the main girders is distributed almost uniformly on all plates and corner brackets, and the component elements of the lower booms of the main girders operate as a single unit.

THE PRODUCTION OF BENT SHAPES

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The most progressive and efficient method of producing shapes, especially of thin-walled and complex form, is the method of bending the flat or sheet material on special bending mills; this method is based on successive changes in the configuration of the cross section while passing it through counter-rotating pairs of rolls which, due to the special pass grooves cut in them, give the bloom the final cross sectional shape.

The production of shapes on bending mills opens wide possibilities for producing shapes of complex configurations, including closed forms (Fig. 1) from sheet metal 0.2-20 mm thick and to 2000 mm wide made of various materials (steel, nonferrous metals and their alloys, etc.).

Because of the efficient distribution of metal along the cross section bent shapes having high rigidity are considerably more economical and lighter than hot-rolled shapes.

According to the exactness of their dimensions and deviation from rectilinearity they belong to the most accurate class of metal articles, do not require additional straightening, and their dimensions can be maintained to the third class of accuracy.

The continuity of the process of manufacturing bent shapes makes it possible to operate at more advantageous speeds, up to 200 m/min, and the effective output is 99.5-99.7%.

It is possible to install additional machines in the same line with the bending mill in order to combine the bending process with other technological operations (e.g., with the packing of cardboard and felt in the production of shapes for automobile windshields, with seam welding of shapes in the production of welded tubes, with soldering in the production of soldered two-layer radiator tubes, with subsequent bending into a circle in the production of bicycle rims, etc.) without interrupting continuity or slowing down the basic operation of shaping. The variety of bent shapes is very diverse; they are manufactured from low-carbon, low-alloy, and sometimes even stainless steels.

The bent shapes for the automobile industry are mainly manufactured out of low-carbon steel. These shapes are primarily small (windshield and other frames for glass, radiator tubes), are shaped from thin (0.18-0.20 mm) and narrow (10-15 mm) flats, but presently shaped metal from thick and wide sheets is used for the frames and bodies of buses, trucks and light automobiles, spars, wheel rims, dumps of dump trucks, parts for trailers, etc.

Bent shapes are widely used in agricultural machinery (linings, frames, brackets, supports, etc.). The annual demand for these just in this field in the USSR for 1960 is approximately 30-35,000 tons.

Bent shapes are widely used in industrial construction and housing as supporting structures of girders and braces where in a number of cases they replace sectional hot-rolled shapes, reducing the laboriousness of production and the consumption of metal by 40-25%.

Shaping in the bending mill differs from rolling, drawing, and extrusion. The area of the cross section of the sheet bar does not change while shaping. The absence of the effect of forward flow and of the possibility of the formation of folds on the shape between the stands, and also of the flats climbing makes it possible to carry out the shaping process simultaneously in several pairs of rolls. The rolls are usually installed in one general

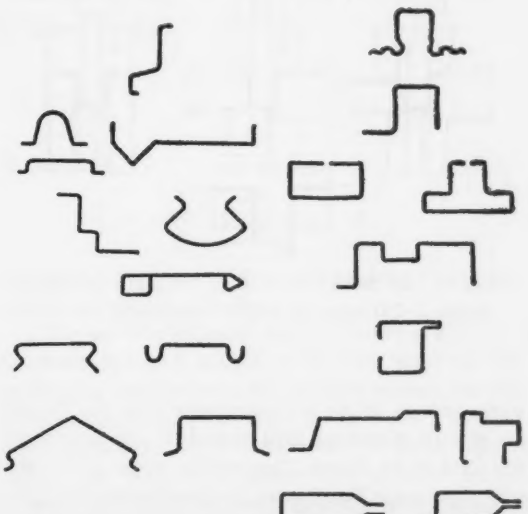

Fig. 1. Views of Bent Shapes.

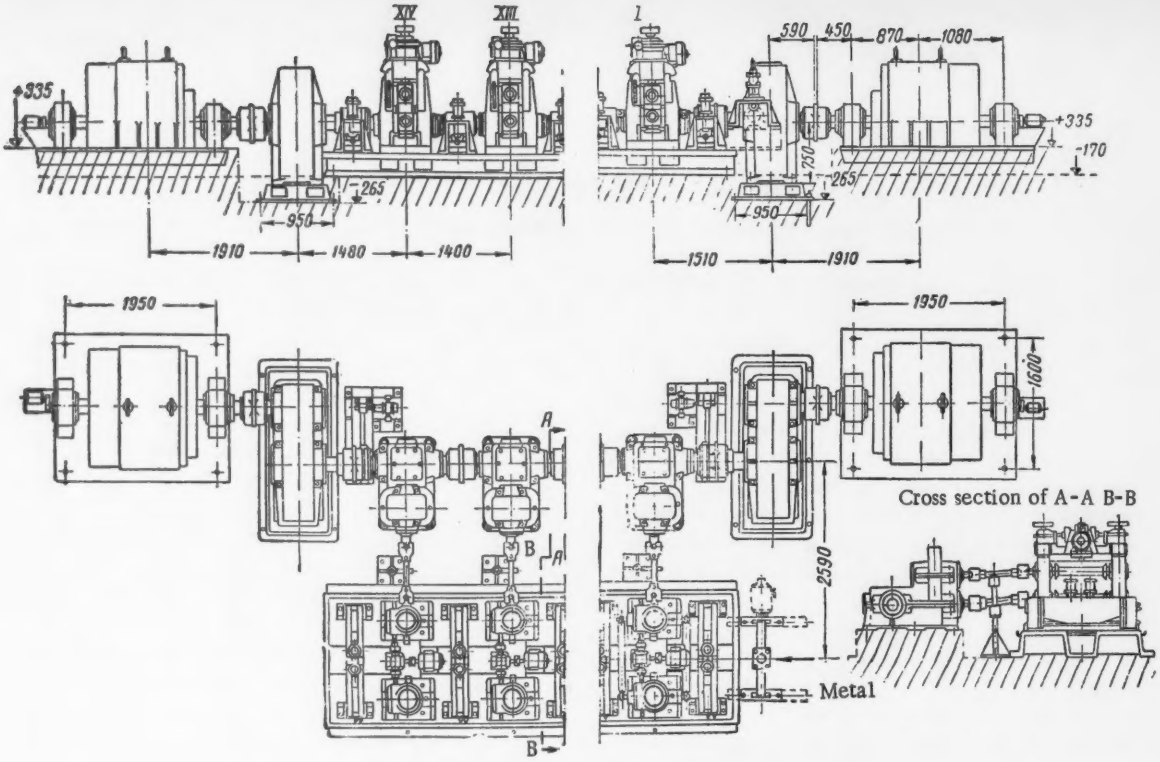

Fig. 2. Roll bending mill: I-XIV) Shaping stands.

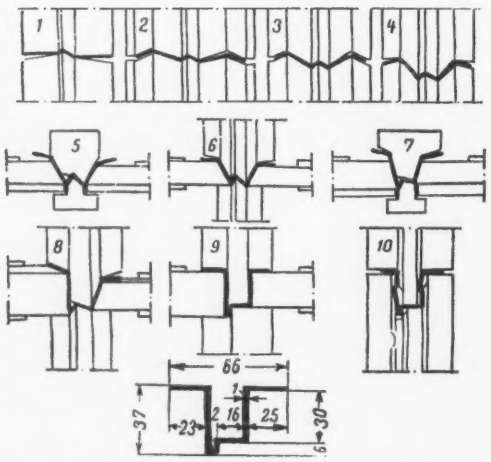

Fig. 3. The process of forming the shape for casements: 1-10) Separate stages of grooving.

frame and are driven from one motor (Fig. 2). The number of pairs of forming rolls depends on the dimensions and form of the shapes. Thus angular shapes and channels with right-angle flanges can be manufactured by four to six pairs of rolls. A greater number of roll pairs are used in the production of more complex shapes.

Selection of the optimum number of rolls is of important practical value. With a large number of rolls the load on each pair is reduced and consequently their wear is decreased, which ensures a higher quality product but increases the cost of equipping.

The forming rolls are attached to the upper and lower drive axles of the stand of the bending mill. Keys are on the axles (shafts) and key grooves in the hubs of the rolls, due to which the torque necessary for shaping and for producing pull is transmitted to the rolls. The rolls can be whole or sectional. Sectional rolls are manufactured for facilitating machining and also for reducing their required number when shaping similar shapes. Thus when shaping girders having similar flanges but different wall widths, it is more economical to use sectional rolls which reduce the inventory necessary for shaping the piece.

The forming rolls for simple shapes do not have sharp angles, are manufactured from structural steel or alloyed cast iron. When the bloom is a hot-rolled sheet the rolls are made from high-carbon or high-chromium steels 9Kh and Kh12M, which resist abrasion well. A high resistance of rolls can also be obtained by using heat-treated instrument steel U10A and U8A. The forming grooves of the rolls are ground and then polished to the ninth class of surface finish.

The roll opening necessary for adjustment, compensation of roll wear, etc. is regulated, as a rule, by the vertical movement of the upper rolls relative to the fixed lower rolls. Bending mills with vertical movement of the lower rolls are used most rarely.

In front of the first pair of forming rolls of the mill, on the guide table, is installed the entry guide designed to center and maintain the flat during its delivery into the first pair of rolls. Lateral vertical idle rollers are installed between the stands of the mill to prevent vertical or horizontal bending of the material and for guiding it to the next stand. These rolls are also used for producing lateral pressure for additional bending of the material. Sometimes slip guides are installed between the stands for directing and shaping the metal instead of lateral auxiliary rolls.

Bronze roller mandrels or slip mandrels fastened on a special bracket are used for final shaping of semi-closed or closed shapes.

On the outgoing side of the last stand of the mill are the delivery guides which prevent curving or twisting of the shape after it leaves the mill.

The number of auxiliary pieces of equipment on the mill depends on the shape being formed and increases when complex shapes are made.

Figure 3 shows the process of shaping of a bent, open-type shape for window casements made of sheet material 135 mm wide and 1 mm thick on a bending mill.

The initial shaping of the right angles is done in the first four stands of the mill. From the fifth stand shaping is accomplished by using lateral idle rollers which produce the required lateral pressure for bending the shape, and the main rolls assure pull. The last, the tenth stand, serves only for final grooving of the shape.

In spite of the economic advantages of using bent shapes, in our country they were not used in production until recently.

Light and medium bending mills are mainly installed in the plants of the USSR. The bent shapes manufactured on them are used, as a rule, for special needs and not as commercial products; the equipment is not mechanized and is not used to full capacity.

Seven standard-dimension bending units are presently planned which will make it possible to manufacture a wide assortment of bent shapes: 1-4×400-1500; 2-7×8-500; 2-6×200-800; 4-10×400-1200; 4-16×600-1500; 1-4×50-400; 0.5-2×30-250 mm.

We have started manufacture of this equipment and it will be installed in the metallurgical plants. The units were developed with consideration of the progressive technology of production, of modern equipment, of high productivity, of maximum mechanization and automation thus assuring continuity of the process. The first two bending units were put into operation at the "Zaporozhstal'" Plant in 1959.

* * *

WORKING EXPERIENCE WITH A UNIVERSAL STAND ON A RAIL-STRUCTURAL MILL

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This year many rolling shops have gone over to producing beams and channels according to the new specifications GOST (All-Union State Standard) 8239-56 and 8240-56 which, in distinction to the old specifications, are typified by deeper webs and reduced flange thicknesses.

From 1954 the rail-structural rolling shop at NTMK began to organize the rolling of No. 22, 24, 27, 30, and 40 beams. Rolling is carried out in the existing stands: one two-high reversing stand (roll diameter of mill, 900 mm), two three-high stands (roll diameter of mill, 800 mm); but instead of the usual finishing stand a universal four-roll stand is used.

The use of a universal stand, as working experience has shown, makes it possible to increase somewhat the broadening coefficient in the finishing groove, but the absence of sliding of the metal on the outside surfaces of the webs and the reduction in the elongation deformations of the metal in the groove have increased the life of rolls and reduced the consumption of electric energy.

In the universal stand the flanges are not reduced in depth, therefore to control the depth of the finished

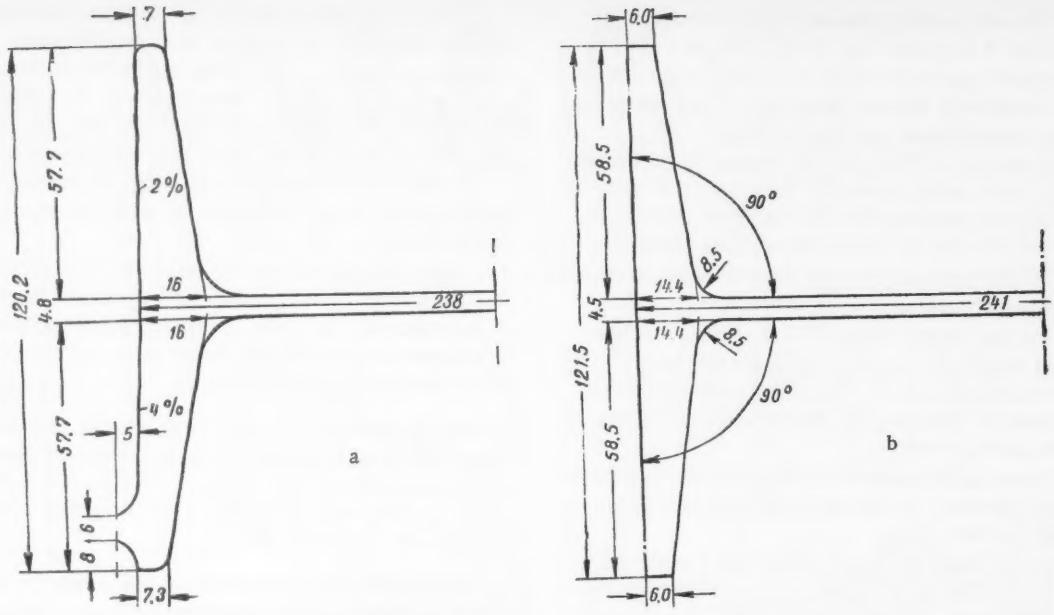

Fig. 1. Passes for No. 24 beams. a) Prefinishing; b) finishing.

flanges a semi-finished section is produced in a semi-enclosed pass (Fig. 1). The lower flange is reduced in depth in the semienclosed pass in the range 3-6 mm. By the use of this pass, a uniform flange depth has been achieved in the finished section.

The universal stand to the UZTM design consists of horizontal and vertical rolls with clamping and balancing equipment.

The upper horizontal working roll 980 mm in diameter is secured to the cap of the housing by housing screws, to which are mounted textolite (resin-impregnated cloth) bearings, braces, springs and nuts. The lower horizontal roll 980 mm in diameter and textolite bearings are mounted in the lower chock and are set up on the lower housing screw. Vertical movement of the rolls during adjustment of the stand is performed with the upper and lower clamping equipment. By revolving the adjustment wheel through 360°, the housing screw advances the roll (upper or lower) by a vertical distance of 6 mm.

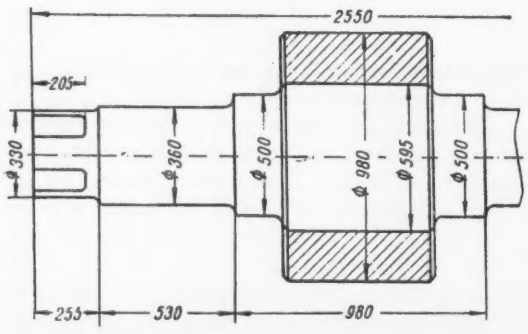

Fig. 2. Built-up roll.

Because of the reduction in the diameter of the horizontal roll journals brought about by the necessity of arranging the vertical roll housing between the journals, the rolls have to be made of steel. Rolling with steel rolls usually leads to frequent roll-changes because of the comparatively low durability of the pass. To avoid this disadvantage, built-up rolls are used instead of steel rolls. These consist of a steel shaft and a cast-iron collar which forms the working surface of the pass (Fig. 2).

The cast-iron collar is put onto the steel shaft hot. The diameter difference specified in practice equals 0.06 mm for an orifice diameter of 100 mm. A collar with this interference pushed onto the shaft will slip from its seating. This is explained by the fact that even with a difference in temperature between the cast-iron collar and the steel shaft of 40°C the interference disappears. A larger interference causes fracture of the collar. To avoid this disadvantage, the fixing of the collar onto the steel shaft was changed: on one side of the collar a shoulder was made onto the roll shaft, and on the other a demountable plate, tightened on with bolts, was installed in a recess.

On built-up rolls up to 3000 tons or more of beams have been rolled while on steel rolls with hardened surfaces only up to 1000 tons could be rolled. As a working measure collars used for rolling large beams can be ground down for rolling beams of smaller dimensions on the same shaft.

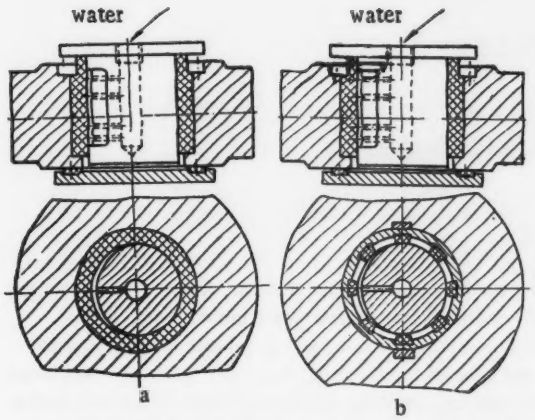

Fig. 3. Textolite bearings. a) Old design; b) new design.

The roll cost on the universal finishing stand is 15-20 kopeks per ton of rolled product whereas even for ordinary beams the cost of finishing rolls per ton of rolled product is on the average 68 kopeks.

The most radical method of increasing the durability of horizontal rolls is to put down a layer of flame-sprayed wire on the working surface. But because of the great difficulty in working the deposited layer this method is not used.

The vertical rolls (undriven) take the form of a hollow cylinder 270 mm high, the external diameter of the working surface being 740 mm. They are set up in a special housing.

The rolls have spring-leveling and clamping devices. A full turn of the screw advances the rolls by 1.6 mm. According to the design the vertical rolls were set up in double conical bearings. Roller bearings were unreliable in use because of unsatisfactory sealing (water used for cooling the journals and working surface of the rolls got into the bearing). Replacement of the roller bearings by bronze bearings did not give good results; two of the tests showed that because of insufficiently reliable grease and the large loads the bronze disintegrated. In further work the vertical rolls have been supported in textolite bearings. The first design for the textolite bearing (Fig. 3a) was not altogether successful because of the poor water-lubrication during the passage of work-piece through the rolls. A more successful textolite bearing design was subsequently developed (Fig. 3b). The new bearings are continuously bathed in water, and this ensures that the textolite is well lubricated during the actual rolling and that it is strongly cooled. Water is supplied at a pressure of 2-3 atm. It is true that this design has its own disadvantages. The textolite bushes are set into a special hollow cylinder, which is braced into the vertical working roll by two keys. This leads to a weakening of the body of the vertical working roll. Increasing the external diameter of the roll is also impossible because of the small dimensions of the housing. Cast-iron vertical rolls frequently broke up during rolling; they were therefore replaced by steel rolls, and the working surfaces hard-faced by wire-flame spraying. The durability of the working surface of such rolls was fully satisfactory. On one set of rolls up to 3000 tons of beams have been rolled; at this point, rolling has given rise to wear on the working surface of the horizontal rolls, but not of the vertical rolls.

On a single pair of vertical rolls, a variety of beams can be rolled.

The universal stand has been set up instead of the ordinary stand. More time is used in roll-changing on the finishing stand than in roll-changing on the prefinishing stand. This is explained by the fact that the reduced size of the horizontal roll journals necessitates a reduction in the diameter of the roll wobblers (from 450 to 330 mm). Therefore the existing coupling boxes and spindles do not satisfy the required conditions and they have to be changed each time on going across to rolling with the universal stand. On changing the rolls of the universal stand because of wear, the upper spindle must be taken off; if this is not done, the vertical rolls and their housings cannot be removed from the stand. Moreover, much time is spent in removing the spindles. At the moment universal spindles have been ordered and are being made; they can be used in working with ordinary rolls and rolls of the universal stand; to do this it will be necessary to replace only the coupling boxes. It will no longer be necessary to remove the upper spindle; it will be raised vertically by special equipment. This measure will make it possible to shorten considerably the time taken in changing to rolls of the finishing stand; this will lead to an increase in output of light-duty beams.

At the side where the work-piece enters and leaves special guiding equipment was installed on the universal stand. According to the plan, guides ought to have been installed on the horizontal and vertical rolls. But their installation considerably complicated the adjustment of equipment and much time was wasted in removing and replacing it during roll-changing.

After being tried out, this special guiding equipment was removed from the stand and replaced by ordinary entrance and exit lines and by an upper and a lower journal guide, which are secured at the working surface of the horizontal rolls on the exit side.

The experience of five years' use of the universal stand on the rail-structural mill has shown that the use of universal finishing stands in rolling beams to the new GOST specification gives satisfactory results.

NEW WORKING STANDS FOR SECTION-MILLS

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VNIIMETMASh (All-Union Scientific Research Institute of Metalworking and Machinery)

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In the production of steel sections, continuous mills are very widely used, with vertically disposed stands, which cut out the process of tilting the metal being rolled.

On section mills two types of vertical stand are used: a) rolls driven from above; b) rolls driven from below.

In working stands with drive from below, roll-changing is made considerably easier, but access to the drive mechanism is difficult, and moreover, the housing has to be very compact with gear transmission for preventing the infiltration of water and scale.

Working stands with drive from above do not have these disadvantages; however, they are typified by their great height, larger weight and the difficulty of changing rolls.

In Fig. 1, a vertical working stand of a medium section mill (roll diameter 350 mm) is shown: this was constructed at VNIIMETMASh, the rolls being driven from above.

The moveable housing of the working stand, assembled with the working rolls, bearings and mechanisms for installing the rolls, rests inside a stationary outer housing, fixed to the base-plate.

The working rolls are installed in blocks on oil-lubricated bearings. To take up axial forces in each block there is a radial thrust bearing. Axial adjustment of the rolls is effected by movement of the upper blocks by means of the screw-in equipment. Each roll has a different installation mechanism, connected to the electric motor through a two-step worm gear. The scheme of operating provides for cooperative and separate working of the electric drive mechanisms to the two rolls. The opening between the rolls is controlled by indicators mounted on the stand.

The drive to the working rolls is effected from electric motors of vertical construction, special geared coupling, composite reducing gear and universal spindles. The electric motor is mounted on the upper flange of the body of the reduction gear, installed directly on the outer housing of the working stand.

The outgoing shafts of the reduction gear are hollow, with splined openings, in which mesh the rear shafts of the heads of the universal spindles. Raising and lowering the stand in changing over from one pass to another are effected by the raising mechanism of the inner-housing. This consists of two screw gears joined below to the outer-housing, and two pairs of female screws mounted in the bore of the housing. The screw gears are connected by a toothed coupling and rotated from an electric motor. The mechanism for raising the inner housing is also designed for roll-changing: the spindles are raised into their highest position and held there by special locking devices; then the framework is withdrawn and installed on the slide-block of the roll-changing mechanism.

The roll-changing mechanism consists of slides built into the outer housing, along which a П-shaped slide-block can move. The assembled inner housing is withdrawn and pulled clear of the outer housing, and in this position the rolls are changed with the overhead crane.

In rolling different profiles and especially section shapes, dual-purpose working stands are very convenient, in which, depending on the section-form, the working rolls can be set up either horizontal or vertical.

The carrier part of such a dual-purpose stand* (Fig. 2), constructed in the Federal German Republic, has an outer housing into which a casset can be installed either horizontally or vertically (Fig. 3). The outer housing envelops the inner housing with the working rolls, bearings and accessories. On the outer housing there are also situated horizontal and vertical pinion housings. To hold the rolling axis constant, the casset is moved with the help of hydraulic equipment.

The accuracy of rolling is one of the most important problems in rolling production. An increase in the dimensions of the finished rolled production above the nominal dimensions leads to an increase in its weight and a waste of metal.

Among the measures directed to increasing the accuracy of the finished rolled product—reducing the temperature fall of the work-piece by raising the rolling speed, reducing the flank-length to diameter ratio for working rolls down to L/D=0.5-1.75, using roller-bearings and liquid lubrication instead of textolite—one must also note the use of preloaded working rolls. The decrease in the range of dimension variation in the rolled product is

* Stahl and Eisen, 1958, No. 22.

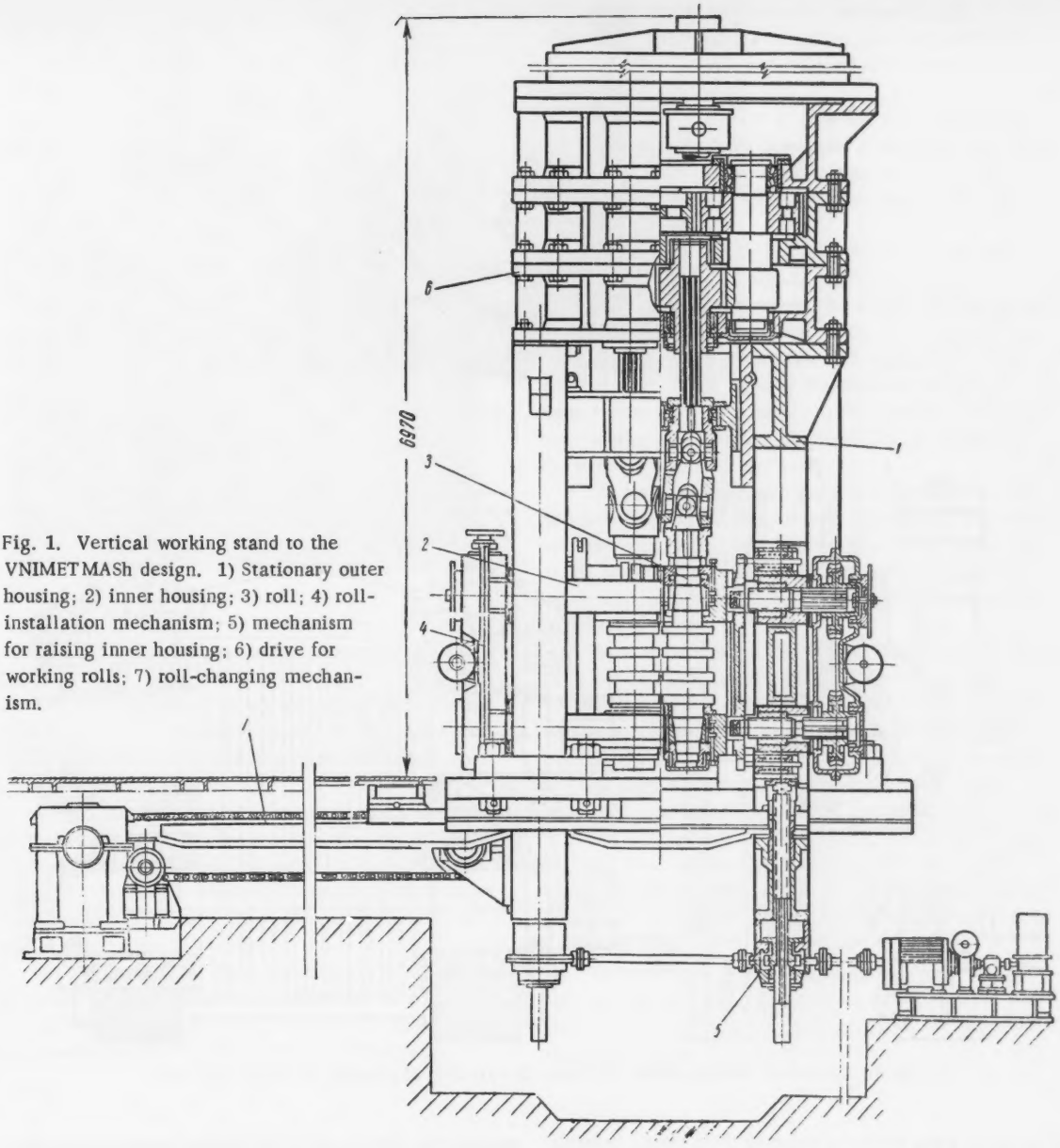

Fig. 1. Vertical working stand to the VNIMETMASh design. 1) Stationary outer housing; 2) inner housing; 3) roll; 4) roll-installation mechanism; 5) mechanism for raising inner housing; 6) drive for working rolls; 7) roll-changing mechanism.

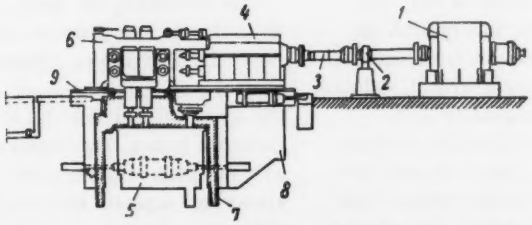

Fig. 2. Dual-purpose working stand. 1) Electric motor; 2) crank bearing; 3) telescopic spindle; 4) pinion housing for horizontal rolls; 5) pinion housing for vertical rolls; 6) casset; 7) carriage; 8) housing; 9) base-plate.

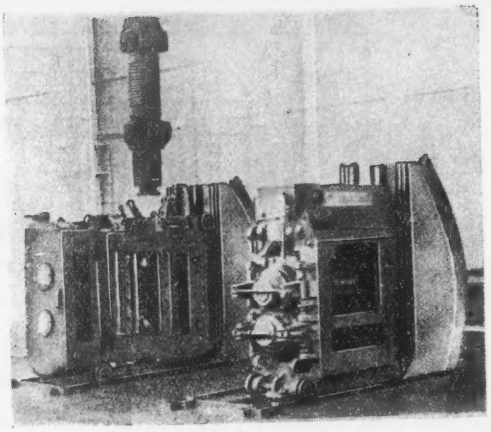

Fig. 3. Casset

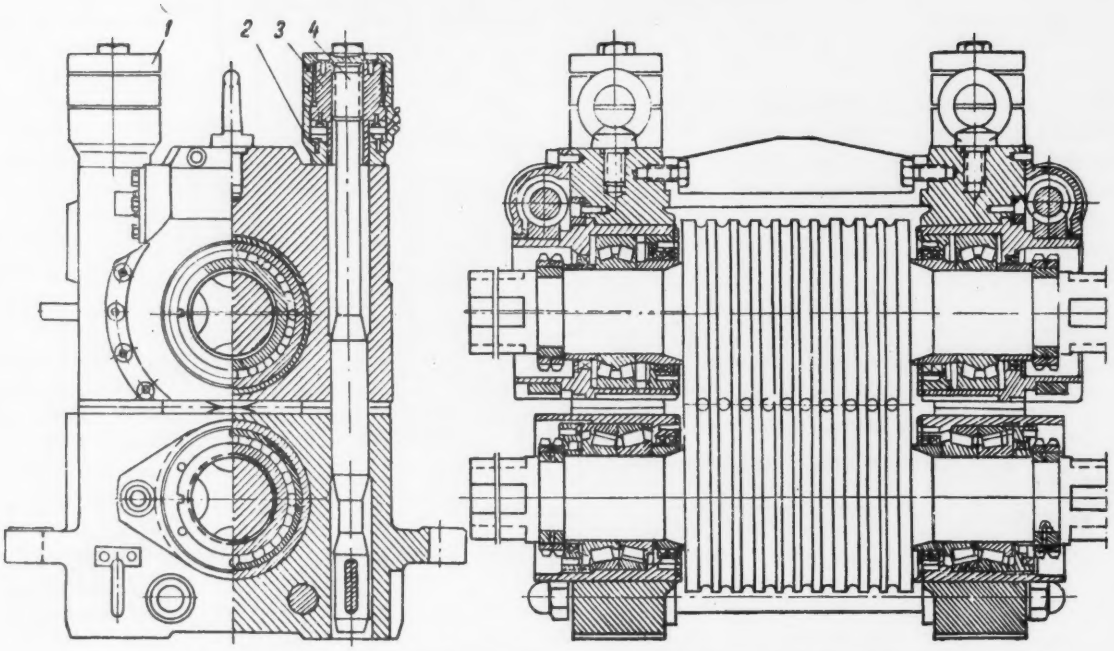

Fig. 4. Preloaded working stand. 1) Block; 2) cylinder; 3) plunger; 4) heavy duty bolt.

achieved in these stands by reducing their elastic deformation.

In Sweden, and also in certain mills in Italy and Czechoslovakia, preloaded stands are widely used, on which, by the reduction in their elastic deformations, the dimension variation in the profile being rolled is reduced.

In Fig. 4 a preloaded stand, designed by S. P. Granovskii and B. N. Kozlov (VNIIMETMASh) is shown. This stand does not have a housing. Blocks on each side are tightened between themselves with the help of heavy bolts and special hydraulic nuts, consisting of a cylinder, plunger and nut. When oil under pressure is supplied to the cylinder, the plunger moves, stretching the bolt. The nut can then easily be tightened and on releasing the pressure the stand is put in the loaded condition, and this reduces its total resilience.

In assembling the stand, first of all the rolls are set up in the vertical position with the help of gaskets between the blocks to be tightened. More accurate setting-up of the clearance between rolls is effected by moving the upper roll, the bearings of which are mounted in eccentric bushes. The bushes can be rotated by hand with two pairs of worm gears. The installation mechanism allows both separate and simultaneous movement of the bearings.

Axial adjustment is achieved by movement of the lower roll. For this purpose, the bearing of the lower roll on the undriven side is fastened in a socket, which can

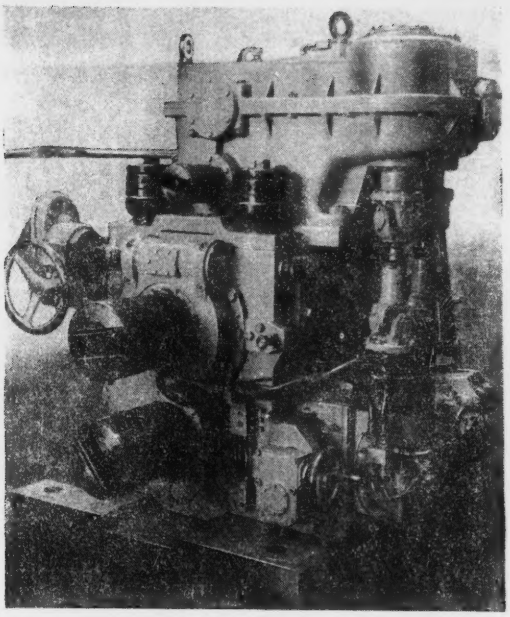

Fig. 5. Universal stand.

be moved in the bearing opening with the aid of cotters and nuts.

The dimensions and weight of preloaded stands are about 1.5 times less than of ordinary stands. This makes it possible to reduce the existing dimensional tolerance on steel section almost by two.

In the USA to obtain accurate dimensions on round sections, there is frequently installed after the finishing stand with horizontal rolls, an additional stand with vertical rolls. Thus in the horizontal stand an oval having a small ration b/h is obtained; in the vertical stand, the oval is rolled down to a round.

In foreign practice (USA, Sweden), universal finishing stands are also well-known, which are used in rolling circular sections with increased accuracy. These stands have horizontal and vertical rolls, the latter being installed on the exit side after the horizontal rolls. A disadvantage of such stands is that the vertical rolls have only one groove which can be combined only with one groove of the horizontal rolls.

At VNIIMETMASh I. S. Pobedin, I. F. Prikhod'ko, and V. A. Revunov have developed a universal mill (Fig. 5) in which each of two or three grooves, cut in the vertical rolls, may be set up opposite any of three grooves in the horizontal rolls.

The horizontal rolls are also set up as in the preloaded stand described above.

To the lower block of the horizontal rolls on the exit side a cross-member is bolted, along which, parallel to the horizontal rolls, a carriage with support with stub vertical rolls can be moved. The support can also be moved vertically with respect to the carriage. Moreover, there is also provision for the possibility of regulating the opening of the vertical rolls.

The stand had been designed to be suitable for the 350 mill of the Stalino metallurgical factory. The vertical rolls are rotated from the free wobbler of the upper roll of the prefinishing stand—an interchangeable two-high stand—through a combined reduction gear and telescopic universal spindles.

Tests of the stand at the Stalino metallurgical factory have yielded good results. Thus, in the rolling spring strip with parabolic edges with a difference in temperature between the leading and tail ends of the strip of 100-130°C, the increase in thickness of the strip toward the tail stood at 0.10 to 0.13 mm as compared with 0.25-0.30 mm in rolling with the old stand. The vertical rolls made it possible to obtain a varition in strip width of ± 0.3 mm, as compared with 0.6 mm specified by GOST (All-Union State Standard). In September, the rejection of strip for incorrect thickness was reduced from 4-5% to 0.85%.

The rolling of 200 tons of steel rounds, 27 and 28 mm in diameter, has shown that its dimensions are maintained with an accuracy of ± 0.1 mm, as compared with the GOST limits of +0.5 and—0.6 mm.

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MODERNIZATION OF NUTS FOR THE SCREW-DOWN MECHANISM OF A BLOOMING MILL

L. N. Gorodetskii

Assistant Chief of the Structural Mill of the Petrovskii Plant

Translated from Metallurg No. 5, pp. 35-37,
May, 1960

The nuts on the screws of the screw-down mechanism of the 1000-mm blooming mill did not have cooling equipment. During operation the screw pairs were extremely heated which impaired the lubrication conditions and considerably shortened their service life.

The design of the nuts required 1240 kg of OTsS6-6-3 bronze for manufacturing one set (two pieces) of nuts.

In order to lengthen the service life of the nuts and screws and to save bronze during their manufacture a new design was proposed for a nut with a water-cooled jacket (Fig. 1). Less than 200 kg of bronze is needed for manufacturing one nut.

The technology of manufacturing the newly designed nuts, which was proposed by the author together with D. A. Khimich, made it possible to master the manufacture of bimetallic nuts in the mechanical shop of the plant without any expenditures for new equipment.

The steel body of the nut is turned to its finishing dimensions and threaded to its completed profile without consideration of the bronze layer. After checking the threading with a thread templet a 6 mm allowance was cut below the bronze along the entire threading. Here it is necessary to round off carefully all sharp transitions in the thread profile in order to avoid developing flaws and cracks during subsequent pouring of the bronze layer.

A place under the jacket is sharpened in the body of the nut, a key seating cut, and two holes of 15 mm diameter drilled for the inlet and outlet of the water.

A blind bottom made of low-carbon sheet steel 15-20 mm thick is welded to the end of the body by a continuous weld (Fig. 2). The cup thus produced is filled with a bronze charge and fine charcoal (for producing a reducing atmosphere while heating the bronze). The charcoal fills a tenth of the inside volume of the cup. The requisite amount of the bronze charge, which consists of shavings and wastes of tin bronze, charged into the cup is determined by the formula

$$Q = 1.1\,\pi \frac{(D^2 - d^2)}{4 \cdot 1000}\,\gamma\, l,$$

where Q is the weight of the bronze charge, kg; D is the outside diameter of the thread increased by the double thickness of the bronze layer, cm; d is the inside diameter of the thread decreased by 1.0-1.2 cm; l is the body length of the nut, cm; γ is the specific gravity of the bronze being charged, g/cm^3; 1.1 is the factor taking into account various losses while pouring.

The charged cup is covered with a lid made of low-carbon steel 25-30 mm thick, in the center of which a hole 12-15 mm in diameter is drilled for the release of gases.

The lid is also welded to the cup by a continuous weld. The hole for the release of gases is strictly con-

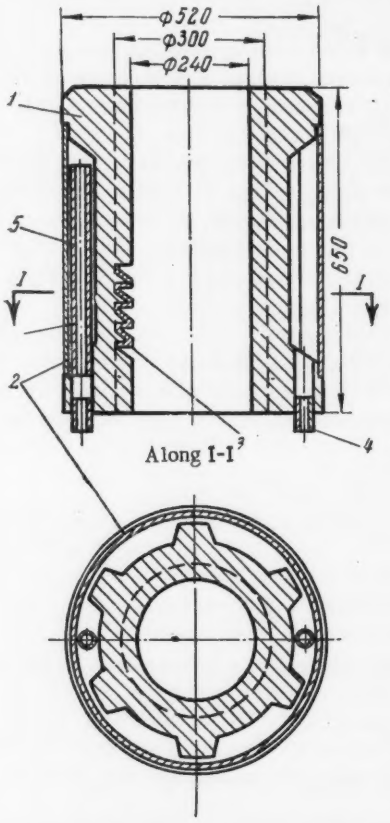

Fig. 1. Modernized nut: 1) Steel body; 2) jacket; 3) bronze layer; 4) inlet pipe; 5) outlet pipe.

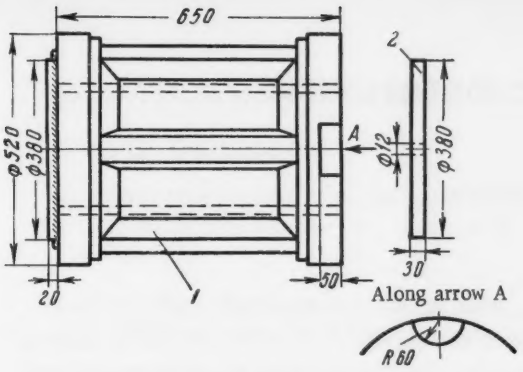

Fig. 2. Blind bottom of the body: 1) cup; 2) lid.

centric relative to the outside diameter of the body.

The body of the nut prepared in this fashion is placed in a gas furnace where it is heated to melting and to a certain overheating of the bronze. The temperature in the furnace is held within 350-400°. The body is thoroughly heated to 1100-1150° for three hours.

Then the body is removed from the furnace, installed by a crane and fastened in the chuck of an ordinary lathe of appropriate dimensions for centrifugal distribution of the bronze on the inside surface of the body. The hole in the lid can be used as a cradle of the revolving center of the lathe tail-stock.

The number of revolutions with which the body should be turned is calculated from the usual formulas for centrifugal casting. Rotation of the body lasts 20 minutes during the course of which it is cooled by compressed air and periodically sprayed with water. Pouring of the bronze must be conducted with observation of all measures of caution and assurance of safety.

The body cooled to 650-700° (a dark red color) is removed from the lathe and placed in dry sand until it is completely cool.

Subsequent machining of the nut consists of cutting the bottom and lid of the thread in the bronze layer. A feature of the last operation consists in determining the middle of the depression of the profile of the steel threads along which the thread cutter is set. For this purpose, before lining the steel body with bronze the start of the coil is marked by a notch. In addition to this, before threading on the bronze the crest of the steel thread is revealed for a length of 8-10 mm.

The inlet and outlet tubes are welded as shown in Fig. 1. The nut is covered by a jacket made of sheet iron 1.5-2 mm thick, the seams of which were electric-arc welded to make them air tight.

Tap water at a pressure of 2.5-3 atm is used to cool the nut.

This modernization will increase the service life of the screw pairs and will save a considerable amount of bronze.

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SELF-LOCKING DEVICE FOR AUTOMATIC CONTROL UNITS

I. Ya. Usik

Senior Engineer-Designer of the Kuznets Metallurgical Combine

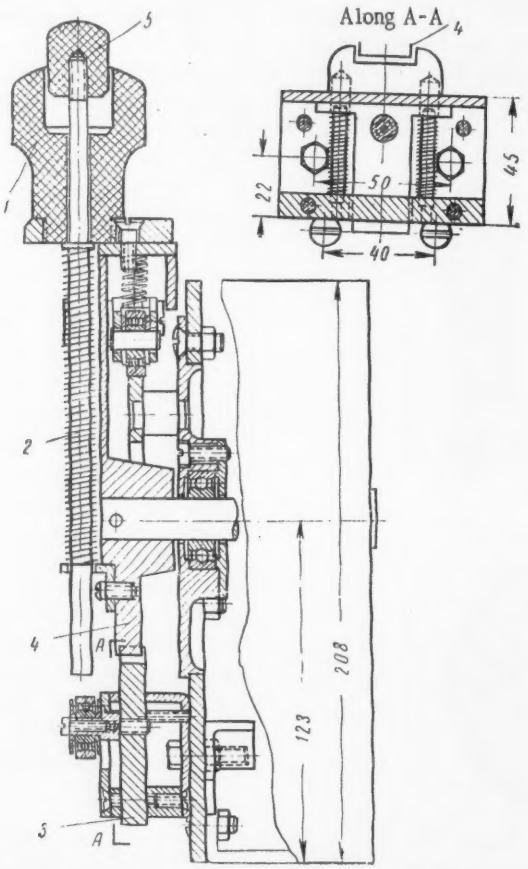
Translated from Metallurg No. 5, p. 37,
May, 1960

The majority of the automatic control units produced for controlling various machines has hitherto been made without special safety devices which would eliminate involuntary (random) switching of the mechanisms into operation. The locking rollers that are used do not always hold the handle of the automatic control unit in the required position.

In order to improve the automatic control unit (figure) a rod was passed through its handle, below the end of which on the outside wall of the automatic control unit a catch was fastened which had a notch to fit the tang.

When the unit is in the switched-off position, the tang enters the notch of the catch (see figure, A-A). In this position it is impossible to shift the handle until the button on the rod is depressed and thus the locking part of the catch will not move down from the tang of the control unit handle.

It is necessary to depress the button only for disengaging the locking part of the catch from the tang, after which the handle can be freely moved to either side.



Self-locking device of the automatic control unit handle: 1) handle; 2) rod; 3) catch; 4) tang; 5) button on rod.

CALCINATION OF LIMESTONE IN SHAFT FURNACES

A. G. Romanenko

Chief of the Limestone Calcination Mill of the "Azovstal'" Plant

Translated from Metallurg No. 5, pp. 38-39,
May, 1960

The open-hearth furnaces of the "Azovstal'" Plant reprocess the high-phosphorous pig iron smelted down from the Kamysh-Burunskii sinter. Successful dephosphorization of metal depends to a considerable degree on the amount of lime delivered while charging and finishing.

In the beginning of 1957 as a result of the increased demand for lime, a new limestone calcination department with a planned annual output of 190,000 tons of metallurgical lime was constructed (figure).

The department consists of four shaft furnaces with a volume of 325 cubic meters of circular section with an inside diameter of 5 m narrowing upward to 4.5 m. The lime is calcined in them by the overflow method.

The shell of the furnace is welded metal. The lining is made of fireclay brick one and a half bricks thick (its thickness is 345 mm). Between the lining and the shell is laid a layer of heat-insulating tripolite brick 65 mm thick which compensates for the expansion of the brickwork from heating.

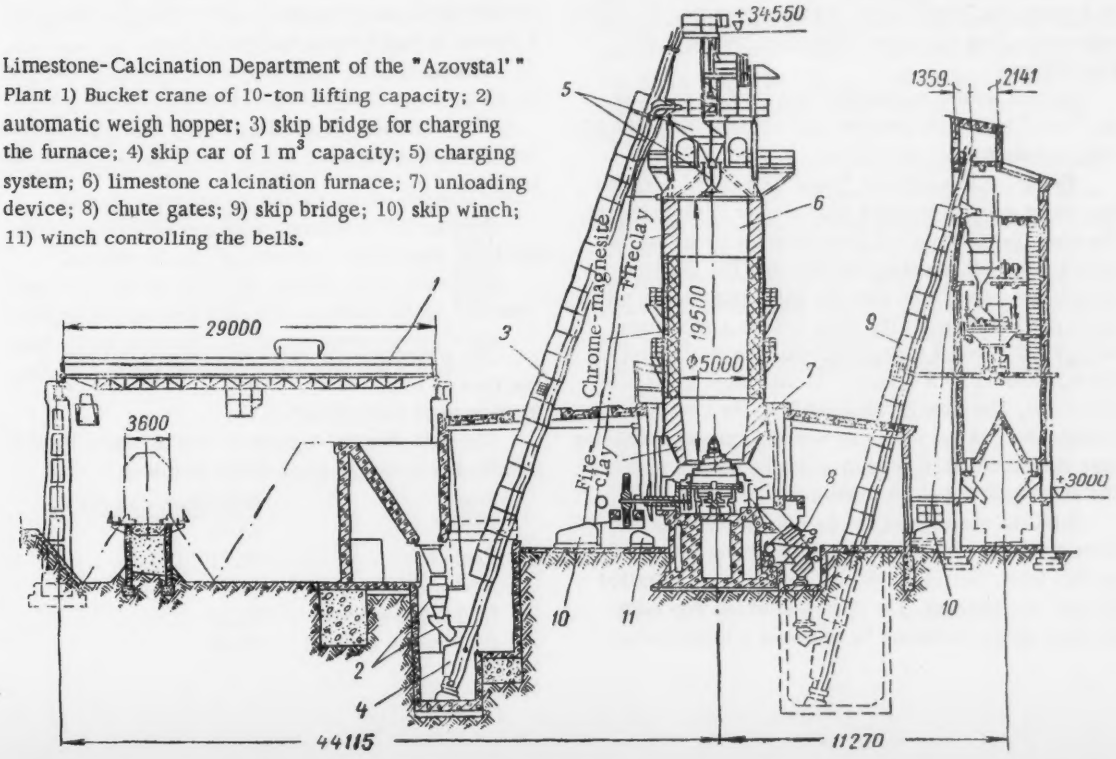
Subsequently the fireclay brick in the calcining zone was replaced by chrome-magnesite brick and an insulation layer of foam fireclay laid.

The brickwork of the shaft rests on a metal ring installed on metal columns with a reinforced concrete foundation.

The furnaces calcine limestone from the Yelenovka deposit in lumps 25-80 mm in size; the content of fines (less than 25 mm) is to 5-8% and lumps (greater than 80 mm) is to 10-15%.

The chemical content of the limestone is, %

CaO	MgO	SiO_2	Other substances
52-54	0.5-1.2	0.6-2.5	43.6



Limestone-Calcination Department of the "Azovstal'" Plant 1) Bucket crane of 10-ton lifting capacity; 2) automatic weigh hopper; 3) skip bridge for charging the furnace; 4) skip car of 1 m^3 capacity; 5) charging system; 6) limestone calcination furnace; 7) unloading device; 8) chute gates; 9) skip bridge; 10) skip winch; 11) winch controlling the bells.

Ordinary metallurgical coke of the Zhdanov Coke By-Product Plant is used as fuel.

The limestone and coke are delivered to an open yard equipped with a bridge bucket crane and a 4-m high unloading trestle from where the cars with the limestone and the hoppers with the coke are unloaded through hatches. Four pairs of receiving bunkers for the limestone and coke are located in the effective zone of the crane. Sectional shutters with electropneumatic drives are on the bunkers. From the bunkers the limestone and coke are loaded through a weigh hopper to the skip car in a weight ratio which was established during the course of the technological process. The materials are delivered by the skip hoist to the top, from where they enter the furnace through the double charging system.

The charging device is a hopper closed by a small bell. When the small bell is open the material from the hopper is poured into the large bell which when lowered turns 22°30'. The bell is a spiral with a scattering blade. According to the concept of the design such a device should contribute to a uniform distribution of the materials throughout the entire section of the furnace.

Charging of the limestone-calcination furnaces is completely automatic. It is controlled by a signal light that signals simultaneously the color and situation of the fire.

At the bottom of the shaft is a mechanism providing semiautomatic unloading of the lime; the main part of it, the "snail", resembles externally the shell of a snail. From above, the "snail" is covered by a pointed dome. As it turns, the "snail", so to speak, screws into the lime, pushing the lime out of the furnace by means of the side surface.

The air needed to burn the fuel is supplied under the "snail" by a high-pressure fan (700 mm H_2O column) with an output of 25,000 m^3/hr.

The space in which the "snail" is located is closed by a cover aranged between the columns of the furnaces. The cover has hatches and peep-hole for observing the operation of the unloading mechanism. The electric drive of the "snail" can vary the speed from 2.8 to 4.6 rev/hr (in four stages). The lime falls on a stationary table, from where it then pours onto a circular conveyor which is rotated by a separate electric drive at a speed of 1.5 rpm. The lime is raked off from the conveyor by a fixed rake into the receiving box of the chute gate having three chambers which open in sequence for one minute. The chute gate has an individual electric drive.

From the chute gates the lime drops onto the belt conveyor and is transported to the receiving hopper of the skip hoist. One conveyor and one hoist are installed for each two furnaces. The operation of the skip hoists has been made automatic by means of a series relay.

The following parameters of the regime are controlled.

1. The pressure of the blast in the pressure line by a U-shaped water manometer.

2. The amount of air delivered to the furnace by a recording differential manometer of the "circular weights" type.

3. The gas pressure at the top by an indicator-type pressure gage.

4. The temperature in the heating zone at two levels (at four points in each) by chromel-alumel thermocouples. Recording type SG-6 galvanometers are the secondary instruments.

5. Control of the temperature of the outgoing gases by chromel-copel thermocouples; the secondary instrument is a profile-type galvanometer.

6. The content of CO_2 and O_2 in the gas is controlled by an automatic recorder.

The entire calcined lime is screened. The lime is taken by the skip hoist to the receiving bunkers of the grader, from which it is sent by a vibrating feeder to the GZh-5 type screens. Of the two available screens, one operates and the other is in reserve. Sieves with a mesh size of 10× 10 mm are placed on the screening machines. The fraction of minus 10 mm is delivered from under the screen to a separate bunker of 155-ton capacity. The lime fraction of plus 10 mm is delivered through a system of chutes to the belt conveyor having a dump car which loads any of the three bunkers for screened lime. The total capacity of the bunkers is 465 m^3 which is approximately a day's supply. In the bunker for fine lime a reserve is kept for one and a half days.

The lime flows from the bunkers into the open cars (hoppers, dump cars, and high-walled platform cars).

The limestone-calcination department was put into operation in January 1957. The output of lime since then is shown below.

Year	Production, tons
1957	169,950
1958	197,483
1959	231,235

The sintering plant requires lime of the fraction less than 10 mm, and the remaining consumers the fraction more than 10 mm.

The mill production costs per ton of output for the individual periods are given below in rubles.

Year	Production cost per ton
1957	83.33
1958	77.71
1959 (first half-year)	81.01
1959 (third quarter)	75.16
1959 (fourth quarter)	77.08

CONSULTATIONS OF "METALLURG"

Translated from Metallurg, No. 5, p. 40,
May, 1960

P. E. Volik, a worker at the "Zaporozhstal'" Plant in a letter to the editor requests an answer to the following question.

A blast furnace was operated at an increased pressure in the top and was changed over to a normal regime. Can the gas cleaners be switched on in this case? How will this be reflected in the operation of the blast furnace?

Let us answer P. E. Volik:

During a prolonged decrease in the gas pressure in the top the gas cleaners must be turned on without fail because without them cleaning of the gas will be completely inadequate (at an increased pressure cleaning of the gas occurs in the choke device).

Switching the gas cleaners on will have no effect on the operation of the blast furnace.

If the gas cleaners are not overloaded they will produce a slight increase in the gas pressure (by 150-250 mm H_2O column). Since the gas pressure in the plant's general gas line is constant (it is determined by the operation of all furnaces) the gas pressure in the furnace top will somewhat decrease (by 150-250 mm H_2O column) when the gas cleaners are switched on.

This decrease in gas pressure in the top will have virtually no effect on the operation of the furnace.

Comrade V. M. Belyavskii of the Odessa Steel Rolling Mill inquires about the causes of the inaccurate coiling of wire rods after the last stand of the 280-mm mill which is manifested in the interweaving of the coils and in the formation of a so-called "basket."

Let us answer V. M. Belyavskii:

Elongation of the wire rod during the pass through the last groove of the finishing stand of the wire mill varies relative to the number of strands being rolled simultaneously and when the next billet is delivered to the rolls the elongation is so insignificant that it is practically nil. Otherwise, the diameter of the wire rod would not satisfy the requirements of the All-Union State Standard with respect to allowances.

The formation of "baskets" when coiling the wire rods with reels having rotating drums (Garrett reels) can most probably be explained by the change in the speed at which the wire rod moves as it leaves the rolls and is wound on the drum of the reels. In order to explain this problem we recommend that you continuously observe the rotating speed of the rolls of the last finishing stand of the mill and of the reel drums and determine how it varies at the rolls in relation to the number of strands of wire rods being rolled simultaneously and at the instant the next billet is delivered to the rolls, and also at the drums in relation to their load by the wire rods and to the change in the current in the electric network.

It is not expeditious to install repeaters between the rolling mill and the reel. It is easiest of all to replace the reels with rotating drums by reels with fixed drums such as those which are presently being used on the modern continuous wire mills. These reels have a number of advantages over the Garrett reels, the main one being that they operate uniformly at any rate the wire rods move within the limits up to 25-30 m/sec.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NIIZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us - Publisher.